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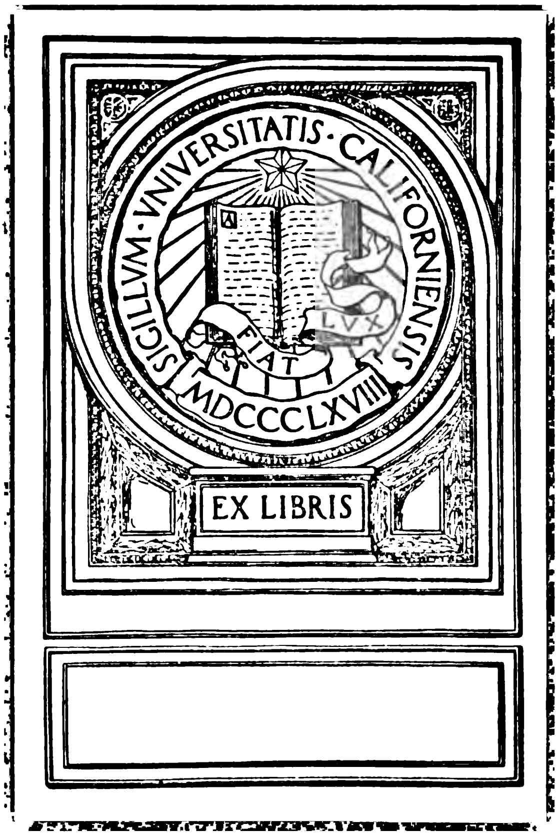

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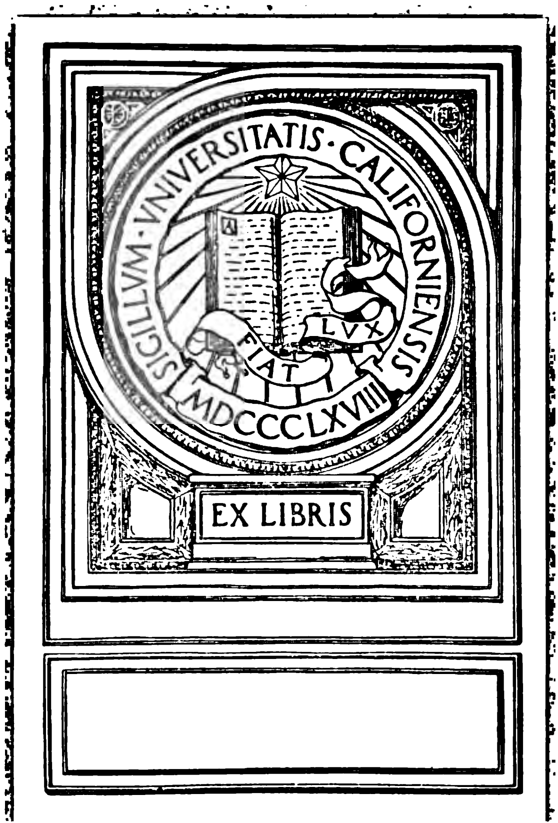

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ADVANCED TEXTILE DESIGN

BY

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PREFACE

The designing and colouring of cloths, which are composed of one series of warp and one series of weft threads, are exhaustively treated in the accompanying book, entitled "Textile Design and Colour, Elementary Weaves and Figured Fabrics." This book forms a continuation of the subject, and deals in an equally complete manner with compound and special cloths in which two or more series of threads are employed in one or both directions, or which are produced in special methods. There is no separate section on colour, but the principles upon which colours are applied to the various classes of cloths are described and illustrated.

Many branches of Textile Design need specialisation, and with this object in view, and as an aid to the adequate treatment of each branch, a large proportion of the matter contained in this work has been specially prepared in the form of separate serial articles which have appeared in textile journals. The chapters on double cloths, special classes of double cloths, wadded and centre-stitched double cloths and treble cloths, on lappet and swivel weaving and designing, and on plain and figured warp pile fabrics, and book-harness muslins, have been published in the *Textile Manufacturer;* the sections on extra weft and extra warp figuring, and gauze and leno fabrics in the *Textile Recorder;* while portions of the chapters on weft pile fabrics and Turkish towelling structures have appeared in *Cotton* (U.S.A.). In re-issuing the matter in book form, most of the original illustrations have been used, but new examples have been introduced and the text has been carefully revised. Further, in order to make the book a complete work on the design and structure of compound and special cloths, chapters have been added on weft and warp-backed cloths, imitation backed fabrics, and backed cloths with wadding threads; on damasks, tapestry and upholstery cloths, ingrain carpets, fancy toilet and quilt fabrics, Brussels, Wilton, Tapestry, and Axminster pile carpets, etc.

Special jacquard and harness mountings, such as sectional jacquard arrangements, pressure and split harness mountings, self-twilling, double-

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cloth, twin, and pile carpet jacquards, inverted hook machines, jacquards with working comber-boards, and gauze and Madras mountings, are fully described and illustrated, as are also the special mechanisms used in weaving lappet, swivel, and Turkish towelling fabrics. The book contains 461 figures, which embody over 2,000 designs, diagrams, and representations of woven fabrics.

The writer wishes to express his indebtedness to several textile engineering firms and many friends for the willingness with which they have placed information at his disposal, and to the publishers and printers for their attention to his wishes in the preparation of the book.

W. W.

GLASGOW, *December*, 1912.

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ADVANCED TEXTILE DESIGN

CHAPTER I

BACKED CLOTHS

Introduction of Extra Threads—Principles of Tying or Stitching. *Weft-Backed Cloths*—Method of Designing—Reversible Weft-backed Weaves—Methods of Weft-Backing Standard Twill and Hopsack Weaves—Warp-Face Weaves Backed with Weft—Method of Selecting Weft Ties—Special Examples of Weft-Backing. *Warp-Backed Cloths*—Method of Designing—Reversible Warp-Backed Weaves—Beaming and Drafting Warp-Backed Designs—Methods of Warp-Backing Standard Weaves—Method of Selecting Warp Ties—Special Examples of Warp-Backing—Comparative Setting of Backed Cloths. *Imitation or Pseudo-Backed Cloths*—Imitation Weft Backing—Imitation Warp Backing. *Backed Cloths with Wadding Threads*—Weft-Backed and Warp-Wadded Designs—Warp-Backed and Weft-Wadded Designs.

Introduction of Extra Threads.—The backed, double, treble, etc., principles of construction are employed for the purpose of increasing the warmth-retaining qualities of a cloth, and in order to secure greater weight and substance than can be acquired in a single structure which is equally fine on the surface. A heavy single cloth can only be made by using thick yarns, in conjunction with which it is necessary to employ only a comparatively few threads per unit space. A heavy single texture is therefore obliged to be somewhat coarse in appearance. By interweaving extra weft, or extra warp, or both extra weft and extra warp threads on the underside of a cloth, it is possible to obtain any desired weight combined with the fine surface appearance of a light single fabric.

In addition to being employed for the sole purpose of giving greater weight and substance to a cloth, extra threads are very frequently introduced for ornamental purposes only, the additional weight of the threads being of no account, while in other cases they are introduced both for weight and ornamentation. In order that comparisons may be made, three classes of cloths are represented in Fig. 1, which are illustrative of the three reasons for introducing extra threads. A shows the face and B the underside of a warp-backed trousering fabric, in which the extra threads are introduced only to give additional weight and substance; C shows the face, and D the underside of an extra-warp figured dress texture, in which the extra threads are solely for the purpose of ornamentation; while E and F show the two sides of a figured double-cloth reversible rug structure, in which the extra threads serve both for weight and ornamentation.

When the extra threads are inserted solely to give additional weight, the idea is to employ them in forming a back to a face fabric; and one of the advantages of the backed, double, treble, etc., systems of construction is that the extra weight can be obtained in an economical manner, since material which is inferior to the face yarns may be used on the underside. Backed cloths are constructed on both the extra weft and the extra warp principle; a cloth consisting in the former case of two series of weft threads and one series of warp threads, and in the latter of two series of warp threads, and one series of weft threads. Double cloths are composed of two series both of weft and warp threads, and treble cloths of three series; while there are other structures which consist of three series of threads in one direction and two series of threads in the other direction. Cloths are not limited to three series of threads in one or both directions, but it is only in special cases that a greater number of series is employed.

Principles of Tying or Stitching.—When extra yarns are employed for weight-giving purposes, it is very important that the threads on the underside are bound to the face-texture with the proper degree of firmness, and that they are entirely invisible from the face side of the cloth. There are many features in tying or stitching which are common to the different classes of cloths, and these features are illustrated in a general way by the illustrations given in Figs. 2, 3, 4. and 5. Each flat view in the figures is shown connected by lines with a plan of the face weave of the cloth that is represented. The dotted lines in the flat views indicate the positions of warp and weft threads on the underside, while the solid black marks show the places where the back threads are raised over the face threads for tying. Corresponding positions of the ties are indicated by the black marks between the squares of the face plans. Assuming that the cloth is simply backed (with warp or weft as the case may be) the stitching marks indicate how the back threads are interwoven; but if it be assumed that both warp and weft threads are employed in forming a cloth below the face fabric the marks only show how the two cloths are united.

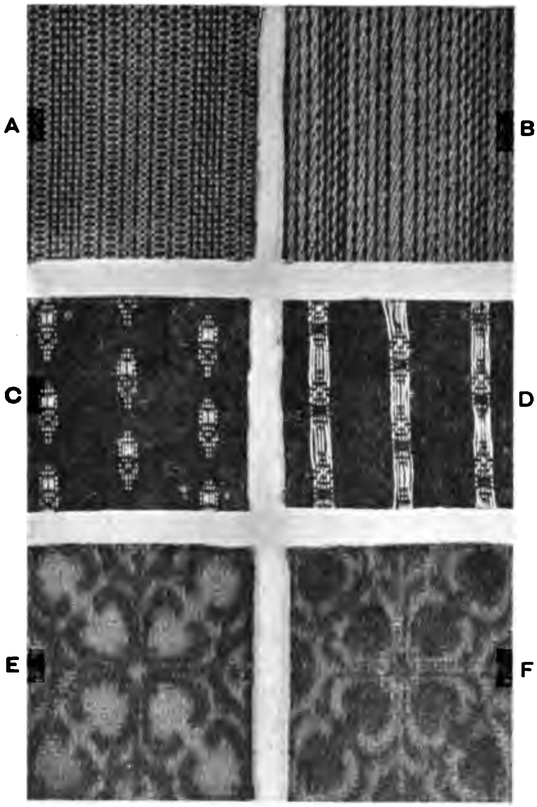


Fig. 1.

In order to avoid the formation of marks or indentations in the face of a cloth, the threads on the underside should float over the threads of the face fabric between corresponding floats in the face weave. It is therefore necessary to carefully select suitable positions for the stitches or ties in the face weave, and for this reason the face weave that is employed largely determines the arrangement of the ties that is most applicable. The basis on which the face weave is constructed should be ascertained, as from this the best order of distributing the ties can, in most cases, be judged. The following orders of distribution are in general use:—(*a*) Twill order, used for twill face weaves. (*b*) Sateen order, used for weaves based upon sateens, and also for the loose binding of twill weaves. (*c*) Plain or alternate order, used in binding certain weaves very firmly. (*d*) Irregular order, used for irregular weaves.

A in Fig. 2 represents a twill order of stitching a 2-and-2 twill face cloth with backing weft, and B with backing warp. In each case the backing threads are stitched with the face threads between corresponding floats in the face weave—*e.g.*, in A, each backing weft stitch is indicated between face-weft floats, and in B, each backing warp stitch between face-warp floats. In the plan which corresponds with diagram A, the shaded marks represent the face-weft floats, while the black marks between the squares show where the backing picks float over the face ends, and coincide with the stitches shown in the flat view. The shaded squares, in the plan that corresponds with B, represent warp up, while the black marks between the squares, which coincide with the stitches shown in the flat view.

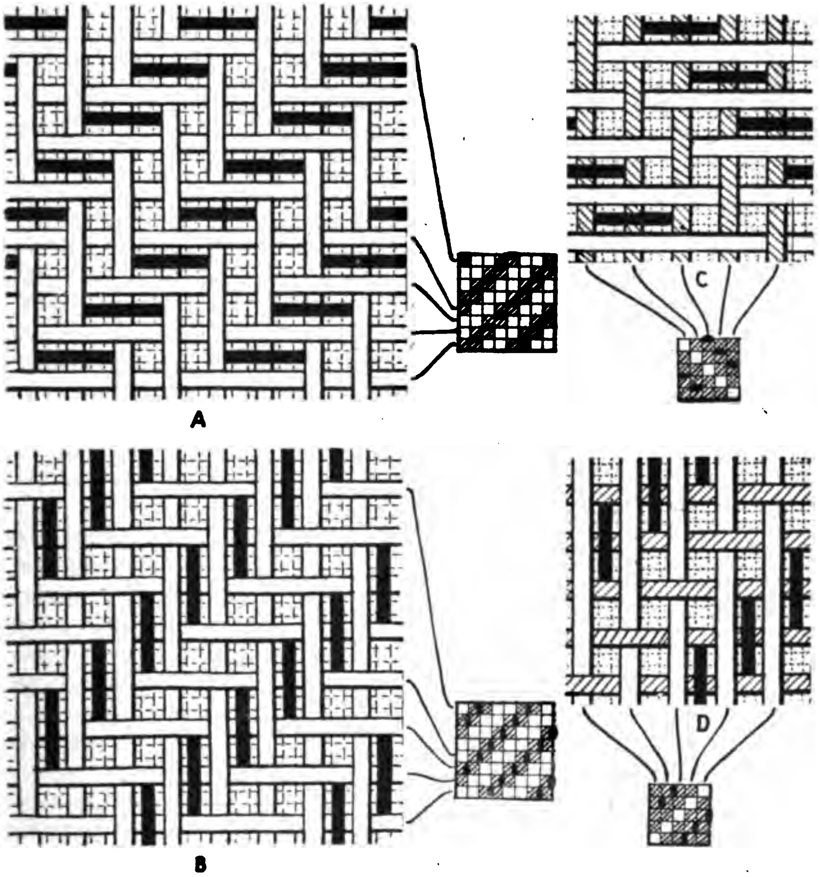


Fig. 2.

indicate where the backing ends float over the face picks. Similarly, C in Fig. 2 represents a 4 weft-and-1 warp twill face cloth, the ends of which are stitched in twill order by the backing picks; while D shows a 4 warp-and-1 weft twill in which the backing ends are raised in twill order over the face picks.

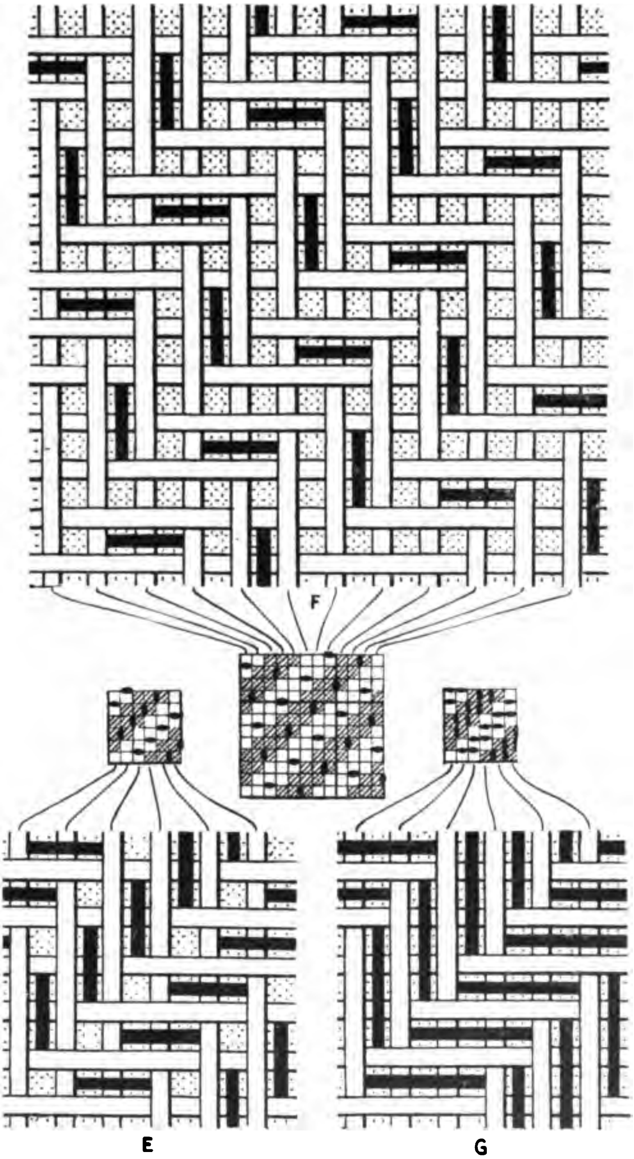


Fig. 3.

The examples given in Fig. 3, in each of which the face weave is 3-and-3 twill, show by comparison that a twill face weave may be stitched either in twill or sateen order. The horizontal black marks in the flat-views represent back weft stitches, and the vertical black marks, back warp stitches. The former would be used in weft backing, and the latter in warp backing; but in a double-cloth structure either of the two, or both methods in combination may be employed, the term "double - stitching" being applied in the latter case. In the plans given in Fig. 3 the weave marks represent warp up, and it will be seen that a warp tie is indicated between two marks, and a weft tie between two blanks. The twill order of stitching, shown at E, coincides with one repeat of the face twill weave, but the sateen order requires the face twill to be extended to two repeats in each direction, as shown at F. Such an extension is necessary, in the 1 face, 1 back arrangement, when the face twill repeats on an even number of threads, whereas a twill that repeats on an odd number of threads requires to be extended to three repeats in each direction to fit with a sateen order of stitching. A sateen order of stitching may be employed for a twill repeating on an odd number of threads, by extending the twill to four repeats in each direction, but in this method the distribution of the ties is not uniform in relation to the twill lines.

As a rule, a backing thread should float over only one face thread at a place, but a system of tying on two consecutive face threads is sometimes employed, as shown at G in Fig. 3, in order to secure firmer stitching than is obtained in the ordinary method. The system can, of course, only be practised when the floats of the face weave are suitable, and when the backing yarn is not too thick. It is very important to obtain the proper degree of firmness of stitching, because the solidity, strength, and wearing quality of a cloth are thereby influenced. For a firm handling cloth the ties require to be more frequent than when a soft handle is desired, while in heavily-milled woollen cloths, the felting of which assists in uniting the back yarns to the face, the stitches do not require to be so frequent as in cloths which are not milled. From a careful examination and comparison of the examples given in Fig. 3, it will be seen how different degrees of firmness of stitching may be obtained in a weave. Thus, assuming that a double cloth is represented in each case, both series of backing threads may be stitched over two face threads in twill order, as shown at G; or over one face thread in twill order, as indicated at E; or over one face thread in sateen order, as shown at F. Or one series of backing threads (either warp or weft) may be stitched to the face in one of the orders represented at G, E, and F. A 3-and-3 twill face weave gives greater scope for variety of stitching than the majority of weaves, but in most cases the firmness can be varied according to requirements.

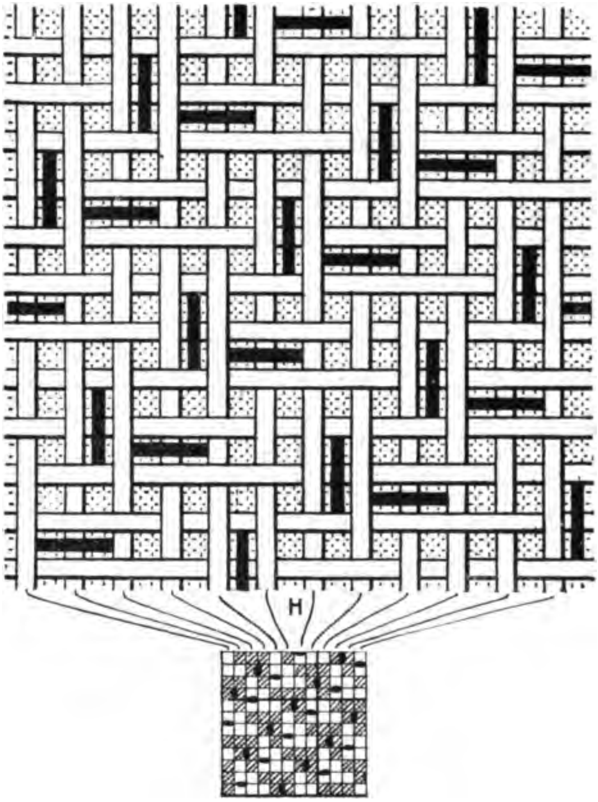


Fig. 4.

The flat view given at H in Fig. 4, and the corresponding plan (in which the weave marks indicate warp up), illustrate both the backing-warp and the backing-weft methods of stitching a sateen derivative face weave, the basis of which is the 12-thread regular sateen. A 12-sateen order of stitching to correspond is employed, and it will be seen that when one tying position has been selected the others follow in regular order according to the basis of construction of the face weave.

A plain or alternate order of stitching is illustrated at I in Fig. 5, in which the 2-and-2 hopsack weave forms the face, while the threads are arranged in the proportion of 2 face to 1 back. Both backing warp and backing weft stitching are shown, and the weave marks in the face plan indicate warp up. This is a very firm order of tying, and in warp stitching enables the minimum number of healds to be employed.

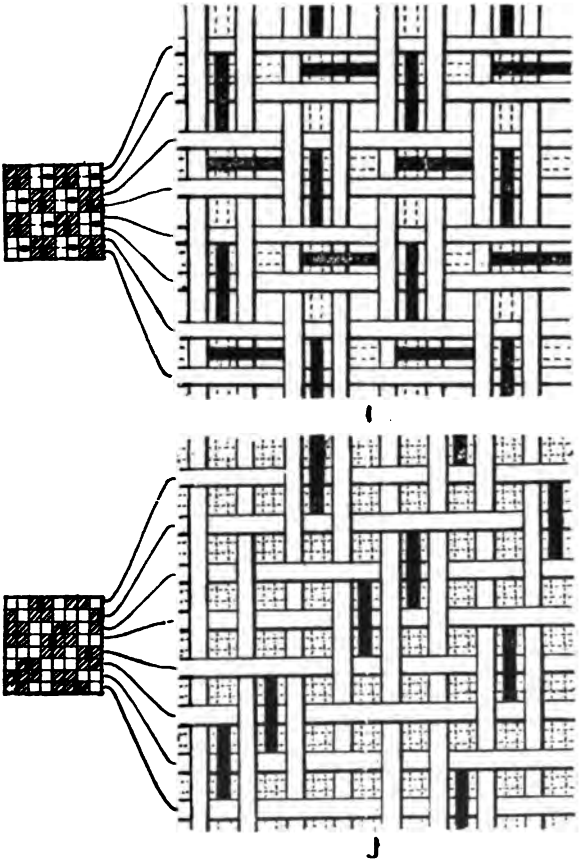


Fig. 5.

J in Fig. 5 illustrates an irregular order of distributing the stitches which is suitable for the irregular face weave that is employed. Warp tying only is shown, but by turning the example one-quarter round, weft tying will be illustrated, the weave marks of the face plan, in the latter case, indicating weft.

Whenever possible it is advisable to obtain the same number of ties on each thread of the series that is employed for tying, and to distribute the ties as regularly as possible over the repeat area. Minor conditions, such as the following, should also be noted. In stitching twill weaves in twill order the ties should fall equally on each warp or weft twill line. If they fall on alternate lines of the twill (as shown in the example given at V in Fig. 8 (p. 9) and at A and B in Fig. 43 (p. 51), adjacent twill lines will appear different from each other. Also, the ties should not run in twill order in the opposite direction to the face twill, as this has a tendency to form a somewhat indistinct cross twill in the cloth. Examples showing this defective arrangement are given at Z in Fig. 8, and at C and D in Fig. 43. In backing-weft tying, if there is a choice of two consecutive positions for a tie in the face weave, it is better to select the first. Thus, in the examples given at E and F in Fig. 3, and at H in Fig. 4, each weft tie would have been situated between face weft floats if it had been placed on the same face end one pick later, but the position indicated is the better, because the beating up of two succeeding covering picks conceals the tie more effectively.

In weft and warp-backed cloths the order of stitching determines the weave on the underside, and for certain kinds of face weaves the back weave may be of two classes—viz. (*a*) The same weave as, or a weave similar to the face weave, the cloth then having very much the appearance of a single structure. (*b*) A loose back weave which is soft in the handle.

WEFT-BACKED CLOTHS

The standard orders of arranging the picks in weft-backed cloths are: (1) 1 face to 1 back; (2) 2 face to 1 back; (3) 3 face to 1 back; (4) 2 face to 2 back; (5) 4 face to 2 back The last two arrangements are used in place of the first two when a different kind of backing weft from face weft has to be inserted in looms with changing boxes at one end only.

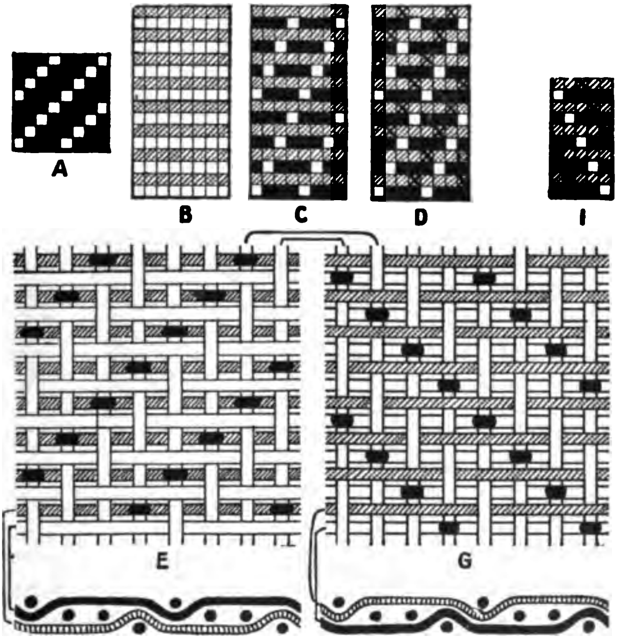


Fig. 6.

Method of Designing.—In designing weft-backed effects it is much more convenient to indicate weft than warp up, and in the accompanying designs the weave marks represent weft. B, C, and D in Fig. 6 illustrate the construction of a design in stages; the face weave is 3-weft and 1-warp twill, as shown at A, and the picks are arranged 1 face to 1 back. First, the position of the backing picks is indicated in pencil or a light wash of colour, as represented by the shaded horizontal spaces in B. Second, the face weave is indicated on the blank horizontal spaces, as shown by the solid marks in C. Third, the stitches are inserted on the backing picks as shown by the crosses in D, care being taken that there is a face weave mark above and below each stitching mark. In the example the stitches are arranged in 1-and-3 twill order, so that the weave on the underside is just the same as that on the face except that the twill runs in the opposite direction when the cloth is turned over. This is illustrated by the diagrams E, F, G, and H in Fig. 6; E shows the face side, and G the underside, assuming that the cloth is turned over from left to right, while F and H represent the interlacing of the first two picks of the respective flat views.

The design I in Fig. 6 will produce a 4-weft and 1-warp twill weave-running to the left on the face side, and to the right on the reverse side when the cloth is turned over. This example corresponds as regards the face weave and the order of stitching with the example given at C in Fig. 2 (p. 3).

Reversible Weft-Backed Weaves.—Weft-backed designs, in which the same weft-face weave is formed on both sides, as in the examples given at D and I in Fig. 6, are a distinct class that is chiefly used for heavily felted cloths which are composed of woollen weft and cotton warp. It is customary to use much thicker weft than warp in this structure, and to insert more picks than ends per unit space, so that the felted and raised finish that is applied to the cloth causes the weft to entirely conceal the warp. A number of designs are given in Fig. 7, which form a weft-sateen weave on both sides, and each design is shown connected by lines with a plan of the face weave. The backing weave is shown by the crosses that are placed on the backing picks, and also by corresponding marks which are indicated between the squares of the face weave. As sateen weaves form a smoother surface than twills, they are more suitable than the latter for the heavily felted woollen weft and cotton warp structures. The designs J, K, L, and M are arranged in the order of 1 face pick, 1 back pick, and they respectively form the 4, 5, 6, and 8-thread weft sateens on both sides of the cloth. In the design N in Fig. 7, the 4-thread weft sateen on both sides is arranged to suit a 2-and-2 order of wefting; in the design O the 6-thread weft sateen is similarly arranged with 4 picks face to 2 picks back; whereas the design P shows the 4-thread weft sateen on both sides arranged 2 picks face to 1 pick back.

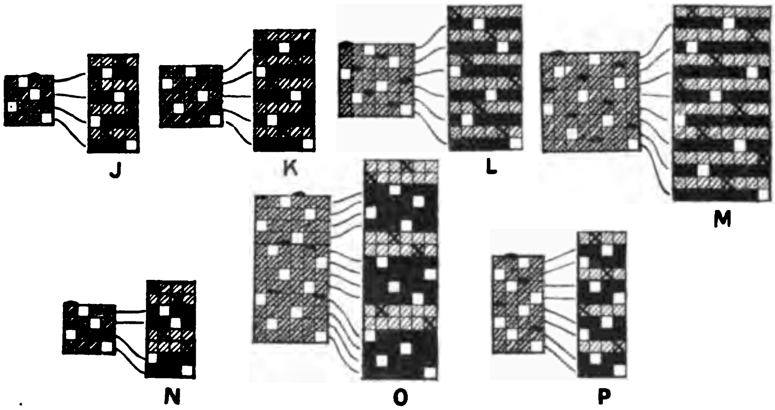


Fig. 7.

Suitable weaving particulars for the design J are: 2/32's cotton warp 40 ends per inch, 12 skeins woollen weft, 60 picks per inch; and for the design K 2/40's cotton warp, 56 ends per inch, 16 skeins woollen weft, 80 picks per inch. The cloths are shrunk from 20 to 30 per cent. in width.

By employing differently coloured wefts for the face and back a cloth is produced in which the two sides are differently coloured, since each weft is retained on one side, while by interchanging the wefts, elaborate designs for dressing gowns, motor-coats, carriage rugs, etc., are woven. (See Figs. 141 to 144.)

Methods of Weft-Backing Standard Twill and Hopsack Weaves.—The examples given in Fig. 8 illustrate different methods of weft-backing the 2-and-2 twill. In the design Q the picks are arranged 1 face, 1 back, and the order of tying corresponds with that represented in the diagram given at A in Fig. 2 (p. 3). The weave on the underside is 1-warp and 3-weft twill, and the cloth is thus as firm on the back as on the face. The drawing R in Fig. 8 shows how the picks 1 and 2 of Q interlace. In the design S the picks are arranged 1 face, 1 back, but the back weave is 8-thread weft sateen. The cloth in this case is looser and softer on the back than on the face, as long weft floats are formed on the underside, as shown at T, which represents how the picks 1 and 2 of the design S interlace. In U, V, and W in Fig. 8 there are 2 face picks to 1 backing pick, but each design, although used in practice, is defective in that the stitches occur only on alternate ends, so that the odd and even ends are liable to vary as regards "take-up." The design V is additionally defective because the ties occur only on alternate face weft twill lines. In U the stitches produce a very firm back, whereas in W the weave on the underside is very loose; the latter design can be drafted into ten healds, as shown at X. The design Y is imperfect, but it shows the best method of weft-backing the 2-and-2 twill when the picks are arranged 2 face to 2 back. In the design Z the picks are arranged 3 face to 1 back, and the stitches are arranged in twill order in the reverse direction to the face twill so that there is a liability of a cross twill appearing in the cloth.

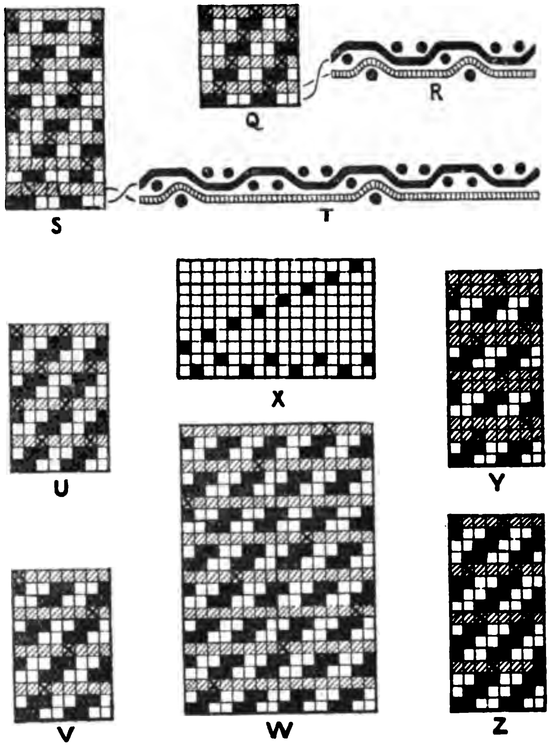


Fig. 8.

Suitable weaving particulars for the design S in Fig. 8, in a worsted cloth are—warp, 2/48's, 62 ends per inch; weft, 20's, 112 picks per inch.

The designs A, B, and C in Fig. 9, which are wefted in the order of 1 pick face, and 1 pick back, correspond, as regards the 3-and-3 twill face weave and the positions of the weft stitches, with the illustrations given respectively at E, G, and F in Fig. 3 (p. 4). In A the backing weave is 1-and-5 twill, and in B 2-and-4 twill, the latter order of stitching being firmer than the former. In C the backing weave is 12-thread sateen, one repeat of which occupies the same number of threads as two repeats in each direction of the 3-and-3 twill. The design D is wefted 1 pick face, 1 pick back, and shows a 12-thread sateen derivative face weave backed in corresponding sateen order, this example coinciding as regards the face weave and the weft stitches with H in Fig. 4 (p. 5). The design E, in which the face weave is 3-and-2 twill, illustrates that in a 1-and-1 arrangement of the threads three repeats each way of a twill on an odd number of threads are required when a sateen back weave is formed. The design F shows the 3-and-2 twill backed with weft in the proportion of 2 face picks to 1 back pick, and this example illustrates that a face weave which repeats on an odd number of threads must be extended to two repeats to fit with a 2-and-1 arrangement. Thus, the design contains 10 face picks and 5 back picks, and repeats on 5 ends, and it will be seen that the back weave is 5-thread sateen.

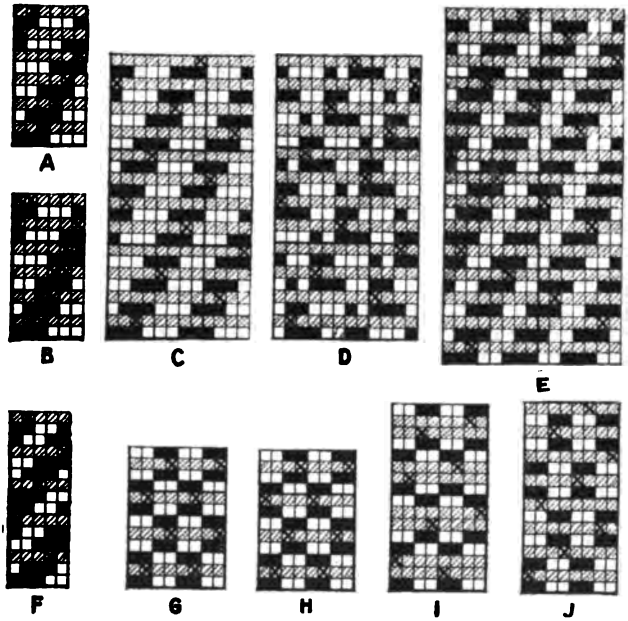


Fig. 9.

The designs G, H, I, and J in Fig. 9 show different methods of weft-backing a 2-and-2 hopsack weave. G and H are wefted in the proportion of 2 face picks to 1 back pick, the backing weave in the design G corresponding with the arrangement of the weft stitches given at I in Fig. 5. H shows a better arrangement of the stitches than G, because in this case a tie is placed on every warp thread. I in Fig. 9 is wefted in the proportion of 2 picks face to 2 picks back, and a stitch is placed on each warp thread. It will be seen that each design, G, H, and I, is so arranged that a backing pick is placed between two face picks that are in the same shed, and not between two picks that cut with each other, so that it is possible to place each stitch with a face weft float on both sides. In the design J the 2-and-2 hopsack weave is backed with weft in the order of 1 face 1 back, and in this case therefore it is only possible to arrange one half the stitches with a face weft float on both sides. A stitch, which is covered on one side only by the face weft, should precede the covering pick, as shown in J, because it is better concealed by the subsequent beating up of the covering pick than if the latter preceded the tie.

Warp-Face Weaves Backed with Weft.—The designs given in Fig. 10 illustrate warp-face weaves that are backed with weft, in which it is only possible to cover each tie on one side. In each example the face weave is shown alongside with the positions of the stitches indicated between the squares, and it will be seen that the back weave is looser than the face weave. The designs K and L both show the 4-thread warp twill backed with 8-thread sateen, but the former, in which the ties follow the face weft floats, is given simply to illustrate incorrect placing of the stitches, the correct method being indicated at L. The design M shows the 4-thread warp sateen backed with a loose irregular weave, while in the design N the face is 5-thread warp sateen, and the back 10-thread weft sateen; the arrangement of the picks is 1 face, 1 back, in each case. The design O is also 5-thread warp sateen face, but the picks are in the proportion of 2 face to 1 back, and the backing weave is the extended 5-sateen.

The type of design given in Fig. 10 is employed for a class of piece-dyed coatings in which a worsted face warp largely predominates in quantity over the face weft (the latter is frequently cotton), while thick woollen weft is used for the back. The cloth is felted and raised on the underside, and is thereby made soft and full to the feel. Suitable weaving particulars for the design N are: Warp, 2/50's worsted, 102 ends per inch; face weft, 2/40's cotton, backing weft, 10 skeins woollen, 96 picks per inch.

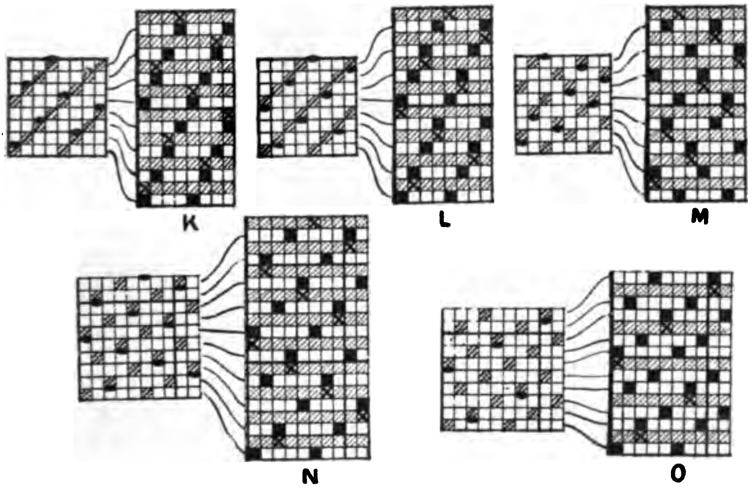


Fig. 10.

Method of Selecting Weft Ties.—The ties for face weaves that are regular in construction are, as a rule, easily arranged, but before constructing a backed design it is convenient, in many cases, to indicate the face weave lightly, and to scheme the distribution of the ties by inserting marks between the squares, in the manner illustrated for example, in the face weave shown alongside the design M in Fig. 10. The ties for irregular face weaves are sometimes difficult to arrange, and in Fig. 11 a convenient method of working is illustrated in stages at A, B, C, and D. The positions of the backing picks, in the order in which they are inserted with the face picks, are indicated, as shown by the marks alongside the face weave given at A; and the first ties are marked between the face picks where only one tying position is available. Second, the ties are marked on the ends which afford only one suitable tying position, as shown at B on the third and seventh ends. Third, the ties are marked in the remaining positions, care being taken to indicate one for each backing pick, and, if possible, to so distribute them that one tie is placed on each end. In the plan C seven ties are correctly indicated, only that of the fourth backing pick being omitted. It will be seen that in order to cover the remaining tie between the floats of the fourth and fifth face picks it is necessary to place it on the second or the eight end, on both of which, however, a tie has already been indicated. In a case of this kind, unless there is a strong contrast in colour between the face and back wefts, it is better to place the stitch with a face weft float on one side only, as shown at D, and thus have the ties properly distributed, than to stitch twice on one of the ends. The complete design may then be readily made, as shown at E, but it is quite convenient to peg the dobby lags straight from a face plan, constructed as shown at D.

Special Examples of Weft-Backing.—As previously shown, in 2-and-1 weft backing, it is frequently impossible to place a tie on every warp thread, and it is only in certain weaves that perfect distribution can be obtained. Twill weaves that repeat on an odd number of threads, are examples in which every thread may be stitched,

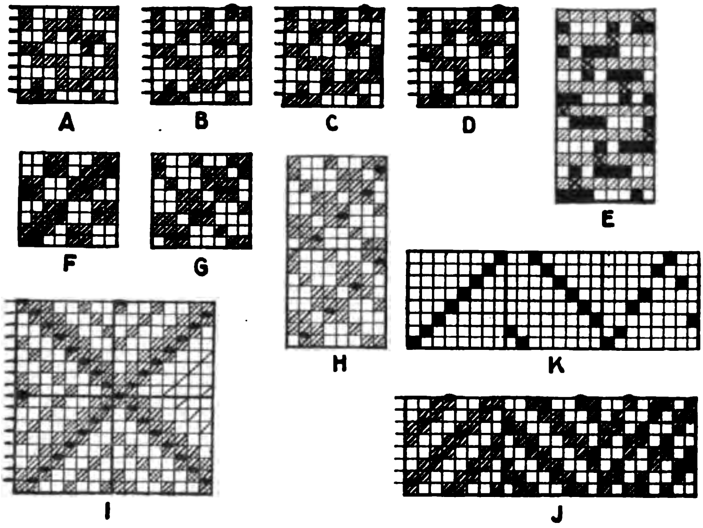


Fig. 11.

as shown in the design F, Fig. 9. A face weave, such as that given at F in Fig. 11, may be stitched on every end, by placing two ties on each backing pick, as shown; while G is an example in which a similar result is obtained by floating each tie over two consecutive ends. A weave, such as G, however, can be stitched on every end by extending it to two repeats, as shown at H (the tie formed by the last backing pick of H should have been indicated on the first end). The design I in Fig. 11 illustrates the principle of weft-backing a diamond weave with the same number of stitches on each end.

In weft-backing a stripe face weave which is composed of derivatives of a simple weave, the stitches require to be carefully arranged in order to avoid needlessly complicating the healds. An example is given at J in Fig. 11, in which the face weave consists of 2-and-2 twill and 2-and-2 twill derivative; the ties are so distributed that an equal number of ends will be drawn on each heald, as shown in the draft given at K.

WARP-BACKED CLOTHS

The arrangement of two series of warp threads to one series of weft threads enables a considerable saving in the cost of production to be effected, as compared with the weft-backed principle, and also permits of the formation of stripe patterns on the underside of the cloth which is impossible in weft-backed textures. Because of the greater strain in weaving, however, such a low quality of backing yarn cannot be used as in weft backing; the drafts are usually more complicated, and a greater number of healds are required in producing similar effects.

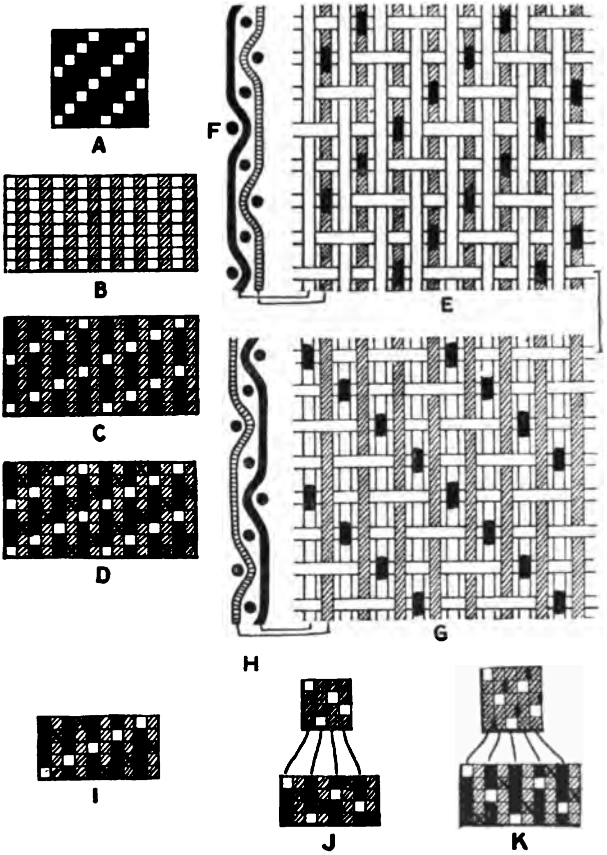


Fig. 12.

The standard orders of arranging the ends in warp-backed cloths are: 1 face to 1 back, 2 face to 1 back, and 3 face to 1 back (there is no necessity to arrange the ends in 2-and-2, or 4-and-2 order); while in some cases a backed weave is combined in stripe or check form with a single weave.

Method of Designing. — In constructing warp-backed designs it is convenient to indicate warp up, and in the accompanying plans the weave marks indicate warp. If the foregoing illustrations of weft-backed designs are turned one-quarter round, and the marks are taken to indicate warp, they will represent warp-backed effects; the following examples are given chiefly in order to enable the two systems of construction to be compared.

The illustrations given at A to I in Fig. 12 respectively correspond with those similarly lettered in Fig. 6 (p. 7), the construction of a warp-backed design being shown in stages at B, C, and D. The face weave is 3-warp and 1-weft twill, as indicated at A, and the ends are arranged 1 face, 1 back. The position of the backing ends is first indicated lightly, as shown by the shaded squares in B; then the face weave is inserted on the blank vertical spaces, as shown by the solid marks in

C. Afterwards the stitches are marked in, as shown by the crosses in D; and, in this case, there should be a face weave mark at both sides of each stitching mark. The order of tying in the example produces a 3-warp and 1-weft twill on the underside so that the cloth is perfectly reversible except for the difference in the direction of the twill lines, as is illustrated by the corresponding diagrams. The flat view, given at E, represents the structure as viewed from the face side, and that shown at G, as viewed from the back, assuming that the cloth has been turned over vertically, while F and H show how the first two ends of the respective flat views interlace.

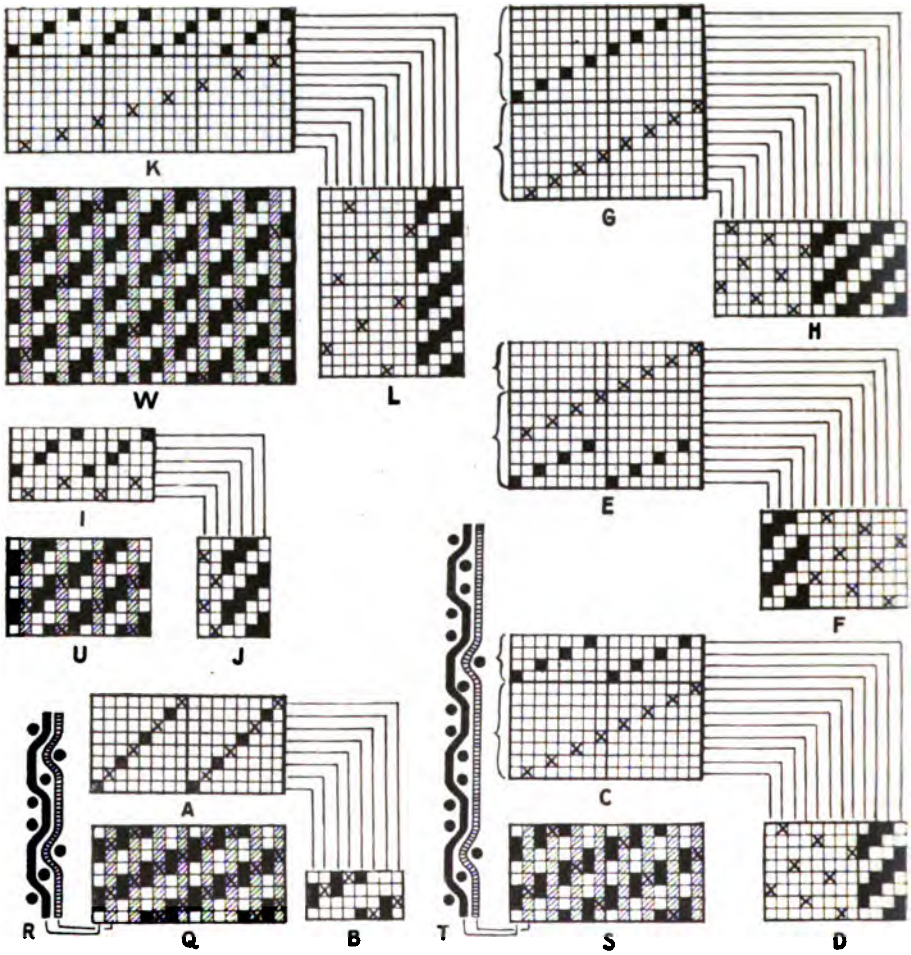


Fig. 13.

Reversible Warp-Backed Weaves.—The design given at I in Fig. 12, in which the face weave and the order of stitching correspond with the diagram D in Fig. 2 (p. 3), will produce a reversible 4-warp and 1-weft twill weave. Warp sateen weaves on both sides of the cloth are constructed in a similar manner, and J and K in Fig. 12 respectively represent the 4 and 5-thread sateen weaves made reversible. (These designs correspond with J and K in Fig. 7.) The cloths may also be made reversible as regards the colouring, or different colour patterns may be formed on the two sides by employing different schemes of colouring for the two series of warp threads.

Beaming and Drafting Warp-Backed Designs.—Fig. 13 shows various methods of warp-backing a 2-and-2 twill face weave, and also illustrates different systems of drafting warp-backed designs. (Q, R, S, T, U, and W in Fig. 13 correspond with the examples that are similarly lettered in Fig. 8.) The designs Q and S are arranged 1 face end, 1 backing end. The order of stitching in Q corresponds with that shown at B in Fig. 2 (p. 3), while R represents the interlacing of the first and second ends of the design. A 3-warp and 1-weft twill is formed on the underside, and the cloth is therefore as firm on the back as on the face. In the design S a loose sateen weave is formed on the underside, as shown at T, which indicates how the first and second ends of S interlace.

In the designs U and W in Fig. 13 there are two face ends to each backing end, but a commencement is made with one face end in order that the backing ends may be readily dented in the reed with a face end on each side. In the design U a plain or alternate order of stitching on the odd face picks is employed, and in W a sateen order is similarly arranged, the ties thus occurring on only half the face picks.

For the design S the following are suitable weaving particulars in a worsted cloth :—Face and back warp, 2/40's, 19 splits per inch with 6 ends per split; weft, 20's, 60 picks per inch. The design U might be woven in a woollen cloth with 30 skeins face warp, 20 skeins backing warp, 10 splits per inch with 6 ends per split; weft 30 skeins, 40 picks per inch.

In beaming the warp for a warp-backed cloth all the threads may be placed on one warp beam, so long as the face and back yarns are similar, and the face and back weaves are equal in firmness, as in the design given at Q in Fig. 13. As a general rule, however, the two series of threads are placed on separate beams, in order that they may be independently tensioned, and there is then no restriction as to the comparative firmness of the weaves or thickness of the threads.

In drafting warp-backed designs simple patterns may be drawn straight over, as shown at A in Fig. 13, which is the draft for the design given at Q. The corresponding pegging plan, given at B, is exactly the same as the design Q. In the draft A the healds which carry the backing ends are intermingled with those upon which the face ends are drawn, and a similar order of drafting upon 16 healds can be employed for the design S, the latter then forming the pegging plan. In cases, however, where there is difference in thickness or material between the face and backing ends, or if different warp patterns for the two sides of the cloth are employed, or if the face weave requires a special draft, it is better to draw each series through a separate set of healds. The healds through which the weaker yarn is passed should be placed at the front, and under ordinary circumstances these are the backing healds, as the backing yarn is usually inferior to the face yarn. If, however, the face and backing yarns are similar the more crowded set of healds may be placed at the front. The two positions of the face and backing healds are illustrated at C and E in Fig. 13, which show two methods of drafting the design S upon the smallest number of healds, while the respective pegging plans are given at D and F. In the draft C the backing healds are shown in front of the face healds, and in E behind them.

The use of only four healds for the face weave, as shown at C and E in Fig. 13, gives very little scope for producing different weaves in the same draft, whereas if eight face healds are employed, as shown in the draft given at G, any face weave that repeats on four or eight threads may be woven. H shows the corresponding pegging plan for the design S.

The draft and pegging plan for the design U in Fig. 13 are given respectively at I and J, and for the design W at K and L; the backing healds in each case being placed in front of the face healds. Fewer healds are required in forming a firm back than a loose back, as will be seen from a comparison of the drafts I and K.

Methods of Warp Backing Standard Weaves.—The examples in Fig. 14 coincide with the designs that are similarly lettered in Fig. 9. Also the designs A, B, and C in Fig. 14 correspond, as regards the face weave and the warp stitches, with the diagrams given at E, G, and F respectively in Fig. 3 (p. 4). The twill order of stitching in A and B coincides with one repeat of the 3-and-3 twill face weave (in the latter design the backing ends are stitched on two consecutive face picks), whereas the sateen order of stitching in the design C requires that the face weave be extended over two repeats in each direction.

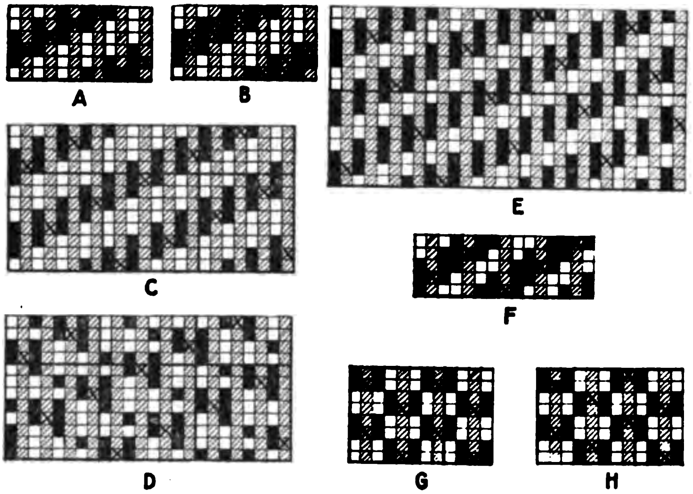


Fig. 14.

The design D in Fig. 14, which corresponds with the face weave and the warp stitches represented at H in Fig. 4 (p. 5), shows a sateen-derivative face weave backed in sateen order. E shows the extension over three repeats in each direction of a twill face weave that repeats upon an odd number of threads in order that it will coincide with a sateen order of stitching. F shows the same face weave as E, extended to two repeats horizontally to fit with a 2-and-1 arrangement of the ends. The design G corresponds, as regards the 2-and-2 hopsack face weave and the warp stitches with the diagram given at I in Fig. 5, while H shows the same face weave backed in 4-sateen order. The latter is a better arrangement than that shown at G.

Method of Selecting Warp Ties.—A convenient system of arranging the ties in warp-backing an irregular face weave is illustrated in stages at I, J, and K in Fig. 15. The face weave is marked in, and the positions of the backing ends—in the order in which they are arranged with the face ends—are indicated below the face plan, as shown at I. The ties are first indicated between the face ends in the places where only one tying position is available, as shown by the marks between the squares of J. Then, as shown at K, the remaining ties are indicated in the positions which will give the most regular and uniform distribution. Afterwards, the draft and pegging plan may be constructed directly from the face plan in the manner represented at L and M.

Special Examples of Warp-Backing.—N in Fig. 15 shows a type of design in which, in a 1-and-1 order of warp-backing, certain of the stitches of the backing ends—in this case the fourth and eight—can only be covered on one side by a face warp float. In a 2-and-1 order of backing the design, however, it is possible to avoid placing a backing thread between the face threads that cut with each other, so that proper positions for the ties can be readily found, as shown at O.

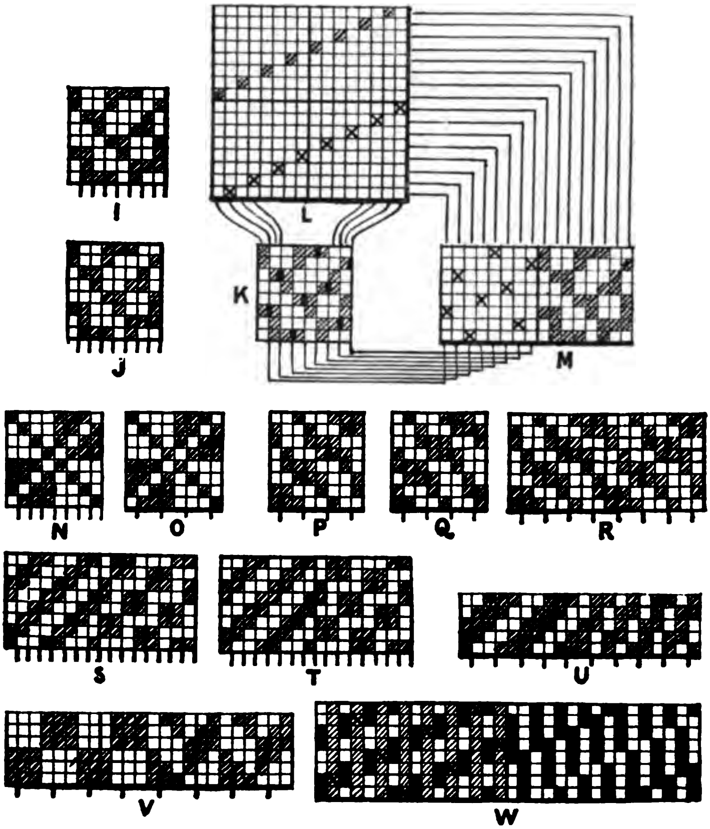


Fig. 15.

P, Q, and R in Fig. 15 show different methods of backing the Mayo weave with warp in the proportion of 2 face to 1 back. In the design P the ties are placed on alternate picks only, but Q shows the face weave in a different position relative to the backing ends which permits each to be tied twice so that a stitch is placed on every pick. R shows another method of tying the Mayo weave on every pick; the face weave in this case is extended over two repeats and each backing end is only stitched once, hence the backing weave is as loose as in the design P. An examination will show, however, that the design R requires twice as many backing healds as either P or Q.

The designs S and T in Fig. 15 show two arrangements of the stitches in a 1-and-1 warp-backed weave, which is composed of 2-and-2 twill and twilled hopsack. In both designs the stitches are correctly placed as regards being covered on both sides by face warp floats, but in S the distribution is not so good as in T. Further, a complicated draft of the backing ends is required in the former, whereas in the latter the draft of these ends is quite regular.

The design U in Fig. 15 shows a stripe face weave, composed of 3-and-2 twill and Venetian, which is backed in 2-and-1 order. In the twill section of the face weave the ties are arranged in sateen order with the picks, and in the Venetian section in twill order, so that in this case both the face and the backing threads require to be specially drafted.

The design V in Fig. 15 shows a stripe weave composed of 3-and-3 hopsack and 3-and-3 twill derivative that is backed with warp in the proportion of 3 face to 1 back. The 3-and-1 arrangement of the threads is particularly suited to the face weave, and the ties are so distributed that only two backing healds are required.

W in Fig. 15 illustrates the combination of a warp-backed 2-and-2 twill with a single weave consisting of an 8-shaft warp corkscrew. The proper ratio of setting the two sections is four ends per split in the backed 2-and-2 twill to three ends per split in the corkscrew.

Comparative Setting of Backed Cloths.—In both warp and weft-backed cloths in which there are two or three face threads to each backing thread, it is customary to use a thicker and poorer quality of backing yarn than face yarn ; and the count number of the backing yarn may be from one-half to two-thirds that of the corresponding face series of threads. The face texture of a backed cloth should generally have rather fewer picks or ends per unit space (according to whether it is weft or warp-backed) than a well-built similar single cloth, this being particularly the case in the 1-and-1 order of backing. For instance, a 2-and-2 twill single worsted cloth made in 2/40's warp and 20's weft, with 60 ends and 60 picks per inch, if backed in 1-and-1 order with weft should have about 60 ends and 112 picks per inch ; and if with warp, about 112 ends and 60 picks per inch.

IMITATION OR PSEUDO-BACKED CLOTHS

Nearly any ordinary weave can be so modified as to produce a structure which very closely resembles a weft or a warp-backed texture, but in which each thread interweaves regularly on both sides of the cloth. The system has the advantages that a heavy single cloth is produced which has a fine surface appearance, and is elastic and soft in the handle, while the threads sustain an equal amount of friction in the manufacture and wear of the cloth. An interior quality of yarn cannot, however, be introduced on the back, since each end and pick is interwoven on both sides, while colours cannot be so effectively applied to the surface as in proper backed cloths. For piece-dyed fabrics, however, the principle of construction is very useful. The designs may be made in imitation of either the 1-and-1, or the 2-and-1 order of backing.

Imitation Weft Backing.—The method of constructing imitation weft-backed designs is illustrated in Fig. 16, in which the marks indicate weft up. In modifying the 2-and-2 twill weave, given at A, to imitate a 1 face, 1 back order of wefting, the repeat of the imitation weave is made one thread less, or one thread more, than twice the number of threads in the repeat of the twill. Thus, in B and C, both of which are imitations of a weft-backed 2-and-2 twill, the respective repeats are on 7 and 9 ends and picks, the former producing an effect which is between a 2-and-2 and a 2-and-1 twill, and the latter an effect between a 2-and-2 and a 3-and-2 twill A line or marks of the original twill is inserted on alternate horizontal spaces of B and C, but as the repeats contain an odd number of picks the twill marks fall first

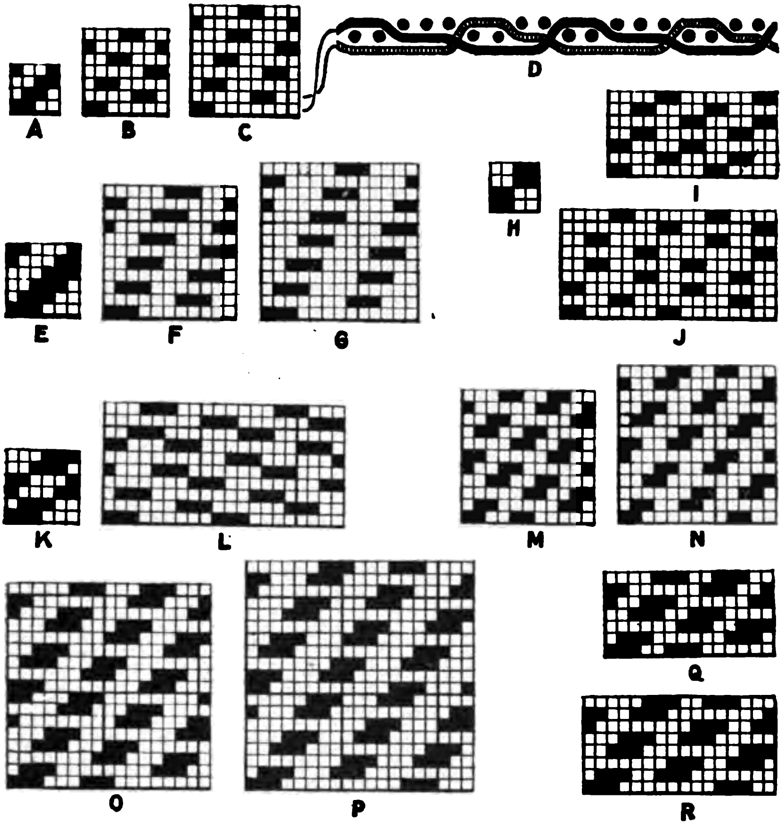


Fig. 16.

on the odd and then on the even horizontal spaces. As shown in the diagram given at D, which represents the interlacing of the picks 1 and 2 of C, the odd and even picks form separate twill lines behind which the even and odd picks respectively float. The designs should be woven with about twice as many picks as ends per unit space in order that the picks will be beaten up very close together, and so cause the twill lines to appear as solid as in an ordinary single cloth. The long weft floats on the underside give the appearance of a loose or sateen back weave, and complete the resemblance to a weft-backed structure.

E, F, and G in Fig. 16 illustrate the modification of a 3-and-3 twill on the 1-and-1 principle; the design F being between a 3-and-3, and a 3-and-2 twill, and the design G between a 3-and-3, and a 3-and-4 twill; the larger weave, of course, allowing of finer setting than the smaller. In the same manner, H, I, and J in Fig. 16 illustrate the modification of 2-and-2 hopsack weave, and K and L of a 3-and-3 twill derivative. In constructing imitation designs that are not twill weaves, a series of floats of the original weave is inserted on the odd horizontal spaces, then a second series is run in on the even spaces, at such a distance from the first series as will give the nearest resemblance to the weave when the picks are beaten close together. In some cases, as shown at J and L, it is necessary to insert several lines of the floats in order to complete the design, each line being placed in the same relative position to its neighbours as the first two lines are to each other.

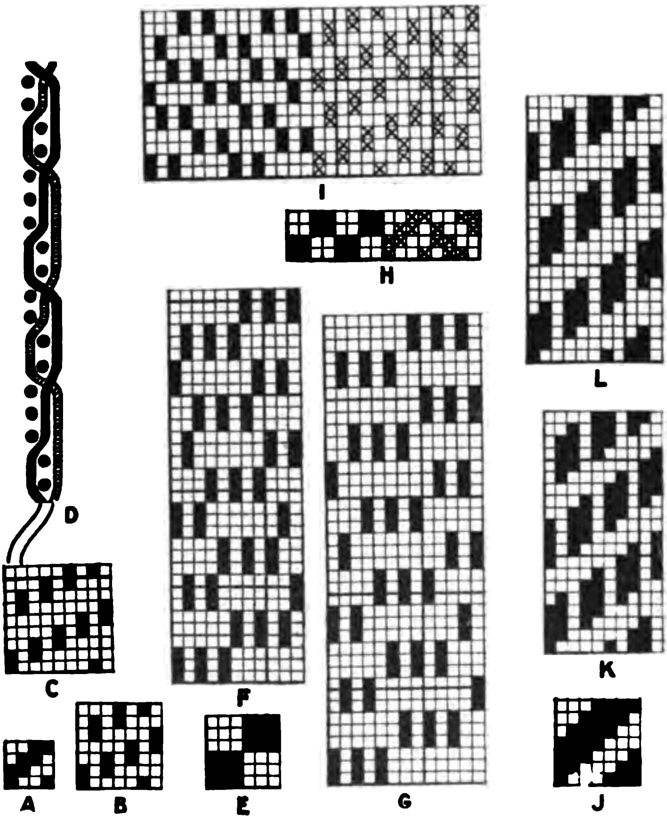


Fig. 17.

In re-arranging twill weaves in imitation of the 2-and-1 order of weft backing, the repeat is made one thread less or one more than three times the number of threads in the repeat of the twill. For instance, a 2-and-2 twill imitation weave may be made on 11 or 13 threads as shown at M and N respectively in Fig. 16; and a 3-and-3 twill imitation weave on 17 or 19 threads, as represented at O and P respectively. A design in imitation of a twill that repeats on an odd number of threads is complete on twice as many threads in one direction as the other, as shown at Q and R in Fig. 16.

These are weft-backed imitations of a 3-and-2 twill and repeat respectively on 14 ends by 7 picks, and 16 ends by 8 picks. Assuming that the 3-and-3 twill modifications given at G and P are woven in 2/36's worsted warp and weft—64 ends and 128 picks per inch will be suitable for the former, and 64 ends and 96 picks per inch for the latter, and in each case the twill will run at 45° angle.

Imitation Warp Backing.—Imitation warp-backed designs are constructed on the same principle as imitation weft-backed effects, and if Fig. 16 is turned one-quarter round and the marks are taken to indicate warp up, the example will illustrate imitation warp-backed structures. In the designs given in Fig. 17, the marks indicate warp, and in order that comparison may be made, the construction of an imitation warp-backed 2-and-2 twill is illustrated at A, B, C, and D, which correspond with the examples similarly lettered in Fig. 16. In this case a line of marks of the original twill is inserted alternately on the odd and even vertical spaces of B and C, so that the odd and even ends form separate twill lines with long floats at the back, as represented in the diagram given at D.

F and G in Fig. 17 illustrate the arrangement in two ways of the 3-and-3 hopsack weave E in imitation of 1-and-1 warp backing ; while I shows a 1-and-1 warp-backed imitation of the stripe weave given at H.

The designs K and L in Fig. 17 show 2-and-1 imitation warp-backed modifications of the 4-and-3 twill given at J, the former containing one pick less, and the latter one pick more than three times the number of picks in the twill.

The 1-and-1 imitation warp effects should have about twice as many ends as picks per unit space, while in the 2-and-1 styles the proportion of ends to picks should be about 3 to 2.

BACKED CLOTHS WITH WADDING THREADS

In this principle of construction the object is to obtain increased weight—as compared with backed cloths—by introducing a thick cheap yarn between the face texture and the backing threads, with neither of which is it usually interwoven. In weft-backed cloths the wadding threads are introduced in the warp, and in warp-backed cloths in the weft, each type thus consisting of two series of warp and two series of weft threads.

Weft-Backed and Warp-Wadded Designs.—The system of constructing weft-backed and warp-wadded designs is illustrated in Fig. 18, in which the weave marks indicate weft. In order that comparisons may be made, the 4-and-4 twill weave given at A is shown arranged on the ordinary weft-backed principle at B, while the construction of a wadded design to correspond is illustrated in stages at C, D, and E. The positions of the backing picks and wadding ends are indicated by different markings at C ; the arrangement is 1 face pick, 1 backing pick, and 1 face end, 1 wadding end. At D the marks of the face weave A are inserted where the face ends and face picks intersect, as shown by the solid marks, while the backing weft stitches, which are represented by the crosses, are indicated between face weft floats where the face ends intersect the backing picks. It will be seen that the weave marks in B are indicated on the odd vertical spaces of D. E shows the completion of the design, the wadding ends being marked down, as shown by the dots, on the face picks. On the backing picks the wadding ends are left blank so that they are raised, and may therefore lie between the face texture and the backing picks, as shown in the diagram given at F, which represents the interlacing of the picks 1 and 2 of E. G shows the appearance of the design E when only one kind of mark is used to represent weft up. All the wadding ends work alike so that only one heald is actually necessary to operate them.

The design represented at H in Fig. 18 shows the weft-backed 3-and-3 twill, which is given at C in Fig. 9 (p. 10), arranged on the warp-wadded principle; the marks of the weft-backed design correspond with those indicated on the face ends of H. In this case there are two face ends to each wadding end, and, as shown by the shaded squares in H, the threads are arranged 1 face, 1 back in the weft, and 1 face, 1 wadding, 1 face in the warp.

A third arrangement of the threads is given at I in Fig. 18, which shows the weft-backed 2-and-2 hopsack weave, represented at H in Fig. 9 (p. 10), wadded with warp in the proportion of 2 face to 1 wadding end. The picks are arranged in the order of 1 face, 1 back, 1 face, and the ends in the order of 1 face, 1 wadding, 1 face. As before, the weave marks on the face ends are exactly the same as in the weft-backed design, and the wadding ends are marked down on the face picks. The section through the weft given at J, which represents the interlacing of the first two ends of I, may be compared with the warp section indicated at F; both diagrams show how the wadding ends lie between the face fabric and the backing weft.

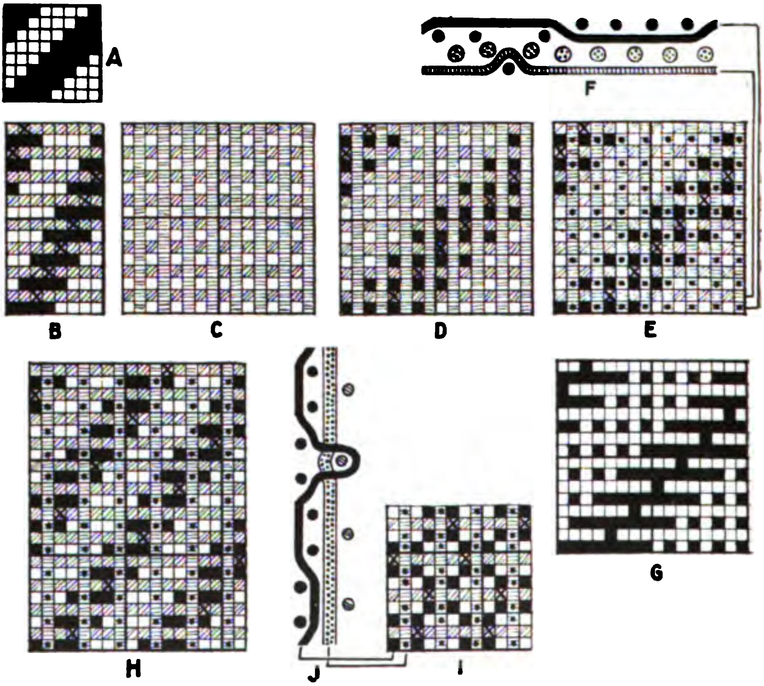


Fig. 18.

Warp-Backed and Weft-Wadded Designs.—The system of constructing warp-backed and weft-wadded designs is illustrated by the examples given in Fig. 19, in which the weave marks indicate warp up. The illustrations lettered K to P respectively correspond with those lettered A to G in Fig. 18. The design L in Fig. 19 shows the 4-and-4 twill K arranged on the ordinary warp-backed principle, while M and N represent different stages in the construction of the wadded design. The arrangement of the threads is 1 face, 1 back in the warp, and 1 face, 1 wadding in the weft, the positions of the backing ends and wadding picks being indicated by the shaded spaces in M. The solid marks in M, which are inserted where the face ends and picks intersect, show the lifts of the face weave; while the crosses, which are placed between face warp floats, represent the backing-warp stitches. It will be seen that the marks on the odd horizontal spaces of M correspond with the marks of the design L. In the complete design given at N the face ends are lifted on the wadding picks, as shown by the dots, whereas the backing ends are left down. The wadding picks therefore lie between the face fabric and the backing ends, as shown in the diagram given at O, which represents the interlacing of the first and second ends of N. P represents the appearance of the design N assuming that only one kind of mark is used to indicate warp up. The drafting of the design is the same as for the warp-backed design L.

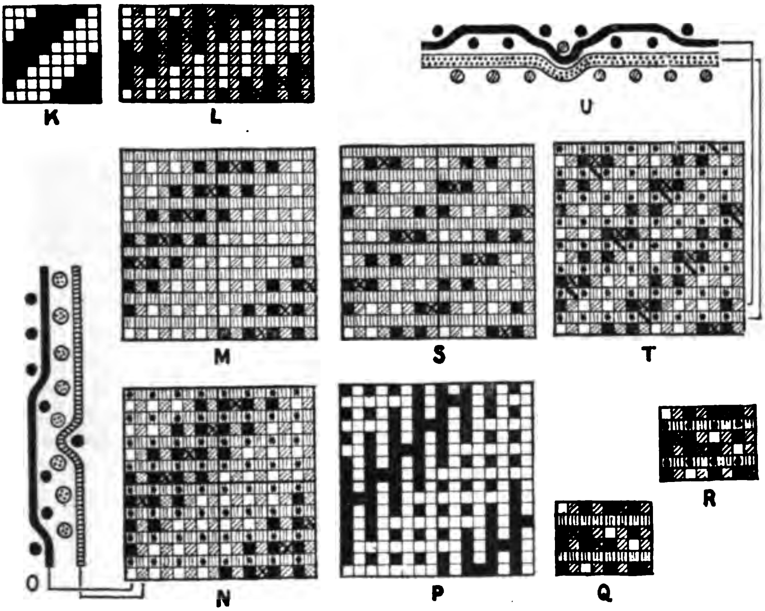


Fig. 19.

Q and R in Fig. 19 show two stages in the construction of a weft-wadded modification of the reversible 4-thread warp sateen given at J in Fig. 12 (p. 13). In this case there are two face picks to each wadding pick. In Q the weave marks of the design J in Fig. 12 are indicated on the face picks, while R shows the wadded design completed by lifting the face ends on the wadding picks.

The weave marks on the face picks of the plan S in Fig. 19 correspond with those indicated in the design S in Fig. 13 (p. 14), which shows a 2-and-2 twill backed with warp in sateen order. The complete weft-wadded design to correspond is given at T in Fig. 19, but in this example a method of interweaving the wadding picks with the backing ends, which is sometimes practised, is illustrated. The diagonal strokes which precede the crosses in T, Fig. 19, indicate the lifts of the backing ends over the wadding picks; it is necessary for these lifts to be made either immediately before or immediately after the backing-warp stitches, in order to avoid breaking the backing-warp floats on the underside of the cloth. The diagram given at U, which represents the interlacing of the picks 2 and 3 of T, shows how the wadding picks lie between the face fabric and the backing ends, except where they pass under the latter at a stitching place. In the design T the wadding picks and backing ends interweave in 8-sateen order with each other and really form a loosely-woven fabric below the face fabric; the former being united to the latter where the backing ends are raised over the face picks.

CHAPTER II

DOUBLE CLOTHS

Double-Cloth Structure—Relative Proportions and Thicknesses of the Face and Backing Threads—Origination or Selection of the Face and Backing Weaves—Tying or Stitching—Construction of the Point-Paper Design—Construction of Double-Cloth Designs for Looms with Changing Boxes at one End only—Double-Cloth Beaming, Drafting, and Pegging—Effect of the System of Tying upon the Number of Healds—Special Features in Double-Cloth Designing—Position of the Backing Weave—Systematic Construction of Double-Cloth Designs—Réversible Double Weaves—Double-Cloths with Compound Face Weaves.

Double-Cloth Structure.—The simplest type of double-cloth is composed of two series of weft and two series of warp threads; one series of each kind forming an upper or face fabric, and the other, an under or back fabric. It is necessary for the face picks to be arranged in definite order with the backing picks, and the face ends with the backing ends. The two series of ends require to be drawn through the healds or harness in such a manner that one series may be operated quite independently of the other series. Separate weaves are required for the two fabrics, which, however, may be either alike or different from each other. Then by interweaving the face picks only with the face ends according to the face weave, and the backing picks only with the backing ends according to the backing weave, two distinct fabrics are formed one above the other. The method in which this is accomplished is illustrated in Fig. 20. The threads are arranged 1 face, 1 back in warp and weft, and a 2-and-2

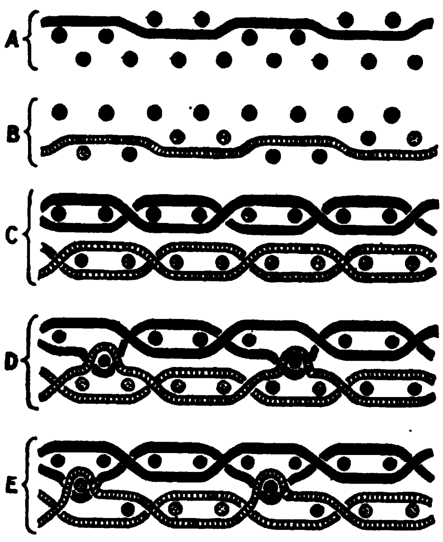


Fig. 20.

weft rib weave is employed for both the face and back textures. A represents the position of the warp threads when the first face pick is inserted. All the backing ends are left down in order that they will be out of the way of the face weft, and half the face ends are raised in forming the face weave. B shows the position of the warp threads when the first backing pick is inserted. In this instance all the face ends are raised in order that they will be clear of the backing weft; also half the backing ends are raised in forming the backing weave. By allowing each series of weft picks to thus interweave only with its own series of warp threads, two fabrics are produced which are quite separate and detached from each other, as shown at C. If, however, a proportion of the face warp threads be left down when a backing pick is inserted, as shown at D in Fig. 20, or if a proportion of the backing warp threads be raised when a face pick is inserted, as indicated at E, the threads of one fabric interweave with the threads of the other fabric; and although there are still two distinct fabrics formed one above the other, they may be so closely united that only one cloth is produced which is equal in thickness and weight to the two single fabrics. The tying or stitching together of the two fabrics forms one of the principal features of ordinary double-cloth designing. If a cloth is not soundly stitched, the two fabrics are liable to become separated from each other during wear, particularly if the back fabric is heavier than the face. Diversity of design and colouring can be applied to both sides of a double-cloth, and at the same time a more perfect structure is obtained than in the case of single fancy cloths or backed cloths.

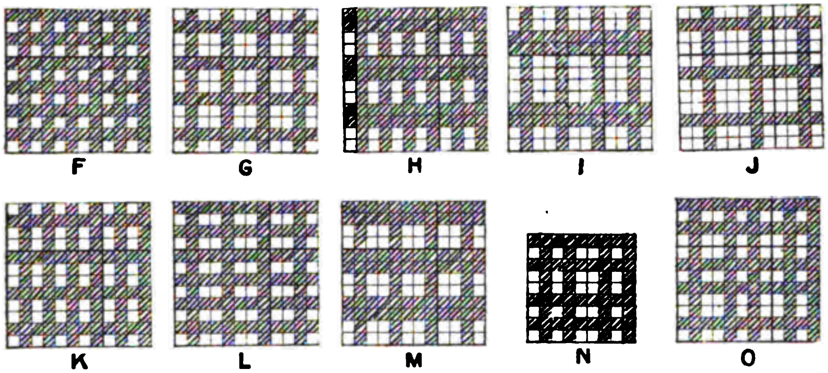


Fig. 21.

The construction of double cloths may be considered under the following heads: The relative proportions and thicknesses of the face and backing threads; the origination or the selection of the face and backing weaves; the tying or stitching together of the two fabrics so as to form one cloth; the construction of the point-paper design; the beaming, the drafting, and the construction of the pegging plan.

Relative Proportions and Thicknesses of the Face and Backing Threads.—These are decided mainly by the weight to be added to the face texture, but the order of arrangement of the threads is determined partly by the boxing capacity of the loom. The most common varieties of double cloths are arranged in warp and weft 1 face, 1 back, as shown at F in Fig. 21, and 2 face, 1 back, as shown at G. For looms with boxes at one end only, and when the backing weft is different from the face weft, similar effects may be obtained in many weaves by changing the wefting to 2 face, 2 back and 4 face, 2 back, respectively, as shown at H and I. Cloths which require a very fine face are sometimes arranged 3 face, 1 back in warp and weft, as shown at J. The threads may also be arranged in a mixed order, as, for example, 1 face, 1 back in the warp, and 2 face, 1 back in the weft, and *vice versa*, as shown at K and L respectively, or 2 face, 1 back in the warp, and 2 face, 2 back in the weft, as shown at M. Irregular arrangements such as 5 face to 4 back (shown at N), and 7 face to 5 back (shown at O), are also employed, and these are useful as they admit of relative proportions of face and backing threads being used which cannot be obtained in any of the regular bases. In addition, special arrangements of threads are employed in the construction of cut double cloths, double plain styles, wadded double cloths, and centre stitched double cloths.

In deciding on the relative thicknesses of the face and backing yarns, a good rule to follow is to have the relative counts about proportionate to the relative numbers of the threads per unit space. Thus, in a 1-and-1 double cloth the backing yarn should be similar to, or not much thicker than the face yarn ; the finest qualities of the structures being usually made the same on both sides. If arranged 2 face to 1 back, the backing yarn may be proportionately thicker, or say, from two-thirds to one-half the corresponding counts of the face yarn; the back being made coarser than the face, particularly when worsted yarns are used for the latter, and woollen yarns for the former. The proportionate counts of the threads, however, depend upon the relative firmness of the face and backing weaves, and the preceding proportions apply to the 2-and-1 arrangement when the backing weave is firmer than the face weave, as described in the next paragraph. If the same weave is used on both sides of the cloth the backing threads may be three or four times as heavy as the face threads in the 2-and-1 arrangement, especially when centre threads are employed for stitching.

Origination or Selection of the Face and Backing Weaves.—When the threads are arranged in equal proportions the backing weave is usually the same as the face weave, or contains about the same relative number of intersections, as, for instance, the 2-and-2 twill is suitable for backing the 3-2-1-and-2 twill. In other arrangements the backing weave is, as a rule, made with a relatively greater number of intersections than the face weave in order to compensate for the reduced number of threads. Thus, in the 2-face, 1 back arrangement, the plain weave is suitable for backing the 2-and-2 twill and the 2-and-2 hopsack ; the 2-and-1 twill for backing the 3-and-3 twill ; and the 2-and-2 twill for backing the 4-and-4 twill. However, in the making of cloths with a fine, smart face and soft back, the same weave may be used, in the 2-and-1 arrangement, for both the face and back textures ; while for a similar type of cloth in a 1-and-1 arrangement of the threads, a looser back than face weave may be employed. The most regular effect is obtained by having the repeats of the face and backing weaves equal, or one a multiple of the other. For example, the 1-and-3 twill is unsuitable for backing the 2-and-3 twill unless the threads are arranged irregularly in the proportion of 5 face threads to 4 backing threads.

Tying or Stitching.—The main principles involved in tying or stitching are described and illustrated in pp. 2-7, but in stitching double cloths, certain conditions are different as compared with backed cloths. In backed cloths, as previously stated, the order of stitching the backing threads to the face fabric gives the weave on the underside. In ordinary double cloths, on the other hand, the stitches simply join the two fabrics together, and, if correctly placed, have no effect on the appearance of either the face or the underside of the cloth. In backed cloths the stitches can only be made by the weft or warp threads (as the case may be) which form the underside, whereas in double cloths there are two methods of tying, since either the backing ends or the backing picks may be employed. Tying with the backing warp, which is termed warp tying, is illustrated by the section given at E in Fig. 20, in which it will be seen that the backing warp interweaves with the face fabric, and the face weft with the back fabric. When the backing picks are inserted, all the face ends are raised, and when the face picks are inserted, all the backing ends are left down, with the exception of the tying ends.

The section given at D in Fig. 20, illustrates the method of tying with the backing weft, which is termed weft tying; in this method the backing weft interweaves with the face fabric, and the face warp with the back fabric. When the face picks are inserted, all the backing ends are left down; and when the backing picks are inserted, all the face ends are raised, with the exception of the tying ends.

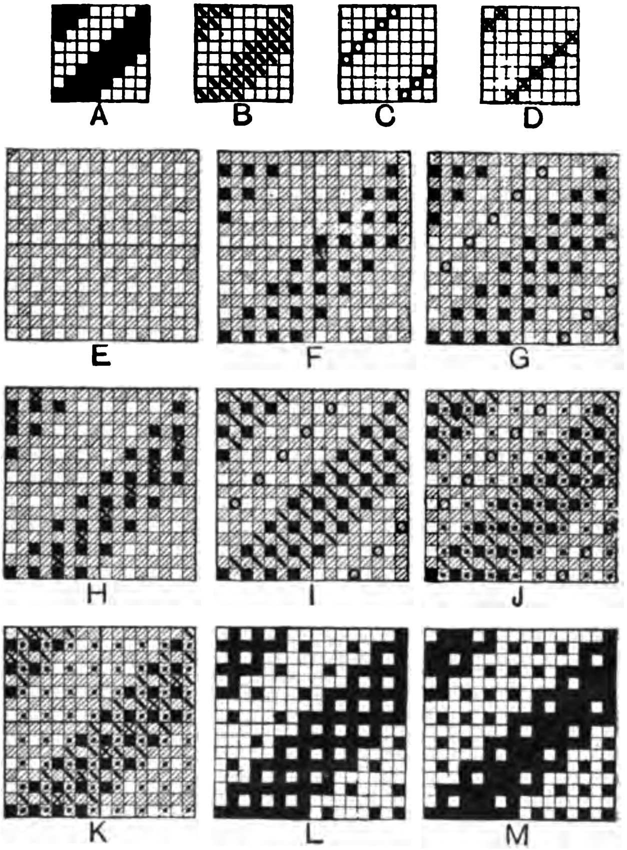


Fig. 22.

The method of tying which is the more suitable is, in some cases, determined by the character of the face weave. If a warp sateen, or a warp twill weave be employed for the face fabric, tying with the backing warp only is suitable; while in the case of a weft sateen or a weft twill weave, it is only advantageous to tie with the backing weft. When there is a choice of the two methods, other things being equal, warp tying is usually preferable, as the warp is less liable to show on the face than the weft. This is because the backing warp, as a rule, is a finer and smarter yarn than the backing weft, and ordinary woollen and worsted cloths contract in finishing more in width than in length. In some cases both methods of tying are employed in combination, as previously explained (p. 4), the cloth being then termed double-stitched.

Construction of the Point-Paper Design.—In constructing backed designs it is clearly advantageous to indicate weft in weft-backing and warp in warp-backing, but in double cloths either weft or warp may be marked with equal facility, and in the following examples both methods are illustrated. Figs. 22 to 33 simply show the construction of designs from given particulars; various factors, which require to be considered before a double weave is commenced, are fully dealt with in reference to subsequent examples. It is sufficient at this stage to assume that in each example the face weave, the backing weave, and the ties, are placed in such positions relative to one another as will ensure that the ties are covered on each side of the cloth as effectively as possible by the adjacent floats.

In order to prevent confusion the different stages in working out a double-cloth design should be represented by different kinds of marks, as shown in Fig. 22, which illustrates, step by step, the construction of a double 4-and-4 twill structure in which the ends and picks are arranged 1 face, 1 back. In this example *marking for weft* is illustrated, and both the warp and the weft method of tying are shown. A is the plan of the face weave, B of the backing weave, C of the warp ties (the circles indicating the order in which the backing ends are raised over the face picks), and D of the weft ties (the crosses indicating the order in which the backing picks are passed over the face ends). The ties are distributed in 8-thread twill order to correspond with the face and backing weaves. The different stages in the construction of the double-cloth plan are shown separately at E to K.

E shows the arrangement of the backing threads with the face threads, the backing ends and picks being represented by the shaded lines. In practice, transparent colour or pencil may be employed.

F shows the face weave inserted. The weave marks are copied from A, and are indicated in the prescribed order on the squares where the face ends intersect with the face picks, as shown by the solid marks.

G shows the insertion of the ties, assuming that warp tying is employed. Each mark (a circle) is placed where a backing end intersects a face pick, and between two blanks alongside each other—*i.e.*, two face warp floats—in the face weave.

H shows the insertion of the ties, assuming that weft tying is employed. In this case each mark (a cross) is placed where a backing pick intersects a face end, and between two marks, one above the other—*i.e.*, two face weft floats—in the face weave.

I shows the backing weave inserted (the warp method of tying being employed). The weave marks are copied from B, and are indicated on the squares where the backing ends intersect with the backing picks—as shown by the diagonal strokes.

J shows the completion of the point-paper plan for warp tying. Backing ends are marked down on face picks (except those which are raised for tying) in order that they will be out of the way when face picks are inserted, as shown by the dots. All the face ends are left blank on the backing picks in order that they will be raised out of the way when the backing picks are inserted.

K shows the completion of the point-paper plan for weft tying. In this case all the backing ends are marked down on the face picks, and all the face ends are left blank on the backing picks, except where the ties occur.

L shows the appearance of the design J when only one kind of mark is used to indicate the weft floats. The marks correspond with those given in J, except that the circles, which indicate the warp ties in the latter, are represented by blanks, as they show warp up.

M is constructed in the same manner as L, but in this case the marks correspond with those given in the design K.

The flat view given at Q in Fig. 23 corresponds with the design shown at J in Fig. 22. The interlacings of both the face and the backing series of threads are shown, and the positions of the warp ties are indicated in solid black. For convenience each solid mark also includes a portion of the backing warp where it floats over the backing weft. By comparing the plan shown at J, or that shown at L in Fig. 22 with the diagram Q, it will be observed that the weave marks coincide with the weft floats, the blanks with the warp floats, and the circles in J with the warp ties. For example, the first face pick passes over the first four and under the last four face ends. It also passes over all the backing ends with the exception of the sixth, which is raised on this pick for tying. The first backing pick passes under all the face ends, but it interweaves with the backing ends by passing over the first four and then under the last four.

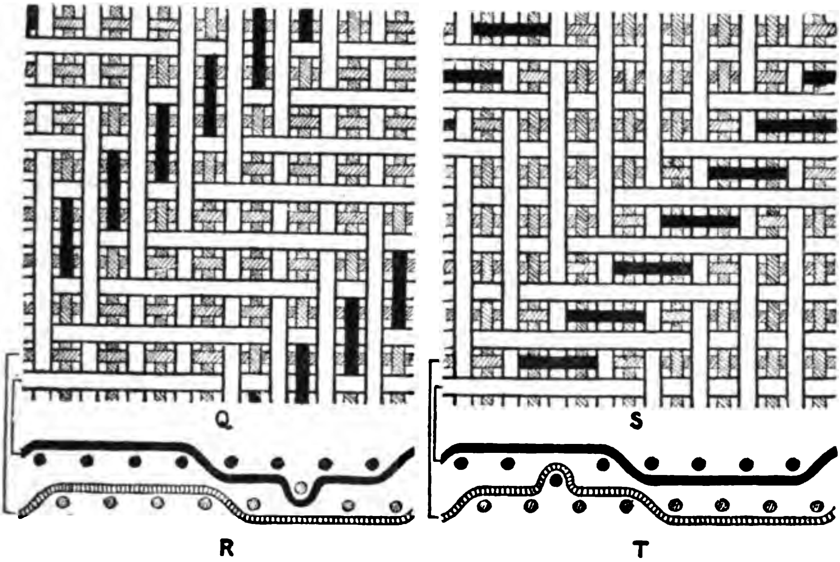


Fig. 23.

The section given at R in Fig. 23 shows how the first face and the first backing pick of Q interlace, and represents in another form the order in which each weft interweaves with its own warp, and how the two fabrics are united by the backing warp entering the face fabric, and the face weft the back fabric.

From a careful examination of Q and R in Fig. 23 it will also be seen that not only will the backing warp ties be covered on the face of the cloth by the adjacent face warp floats, but in addition that where the face weft enters the back fabric for tying it will be concealed on the underside of the cloth by the adjacent backing weft floats. This is evident, because where a backing end is raised over a face pick for tying, it is also raised over the backing picks which precede and succeed the tie, and the lifting of the backing warp gives a corresponding backing weft float on each side of the face weft stitch, on the underside of the cloth.

S in Fig. 23 shows a flat view of the weave given at K in Fig. 22, the positions of the weft ties being indicated in solid black. In this case each solid mark also includes a portion of the backing weft where it floats over the backing warp. By comparing the drawing with K or with M it will be observed that the interlacings of the threads coincide with the marks and blanks on the point-paper. Thus, the first pick passes over the first four face ends and under the last four, while it also passes over all the backing ends. The first backing pick passes over the first four and under the last four backing ends, but it affects the tying by passing in addition over the third face end. A section representing the interlacing of the first face and the first backing pick of S, is given at T in Fig. 23, which shows that the two fabrics are united by the backing weft entering the face fabric, and the face warp the back fabric. On the face of the cloth the backing weft ties will be covered by adjacent face weft floats, while on the back the face warp ties will be covered by adjacent backing warp floats, because where the backing weft floats over the face warp for tying it also passes over the backing ends on each side of the tie, and a corresponding backing warp float on the underside of the cloth results on each side of the face warp stitch.

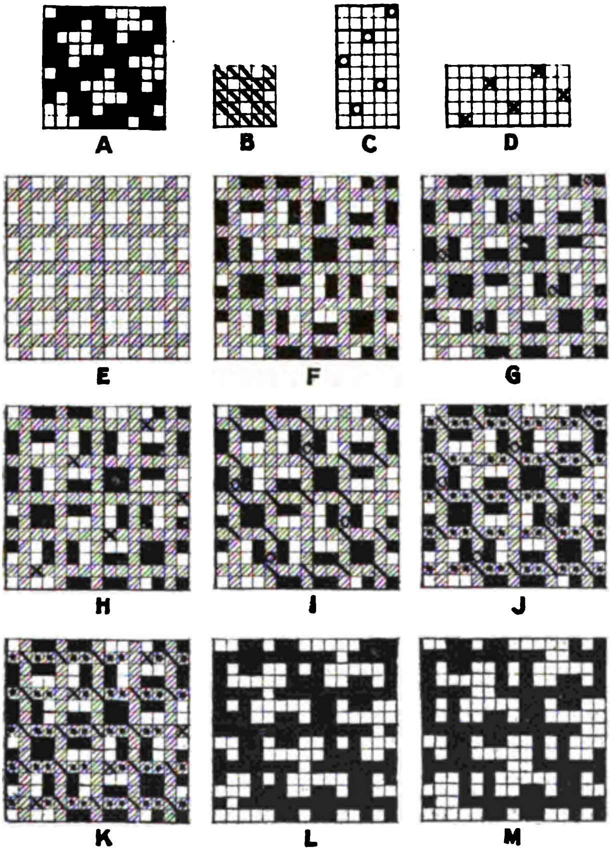


Fig. 24.

The method of constructing the plan of a double cloth, in which the threads are arranged in the proportion of 2 face to 1 back in warp and weft, is shown in Fig. 24. As thicker yarn may be employed for the back fabric than is possible in the 1-and-1 order, this arrangement may be used conveniently in the manufacture of fine face cloths in which the underside is composed of heavy yarns. The 10-thread fancy weave given at A in Fig. 24 is used for the face fabric, and the 5-thread sateen (with weft surface on the underside), shown at B, for the back fabric. Both the backing warp and the backing weft method of tying are shown, the warp ties being formed by raising the backing ends in 5-sateen order over alternate face picks, as indicated at C, and the weft ties by passing the backing picks over alternate face ends in a similar order, as represented at D.

In Fig. 24 the different stages of working are indicated separately in the same manner as in Fig. 22, and corresponding stages are similarly lettered in the two figures, but in Fig. 24 *marking for warp* is illustrated. E shows the arrangement of the face and backing threads; the face weave is inserted at F; the circles in G indicate the positions of the warp ties, and the crosses in H the positions of the weft ties; the backing weave is inserted at I; while the complete design for warp tying is given at J, and for weft tying at K.

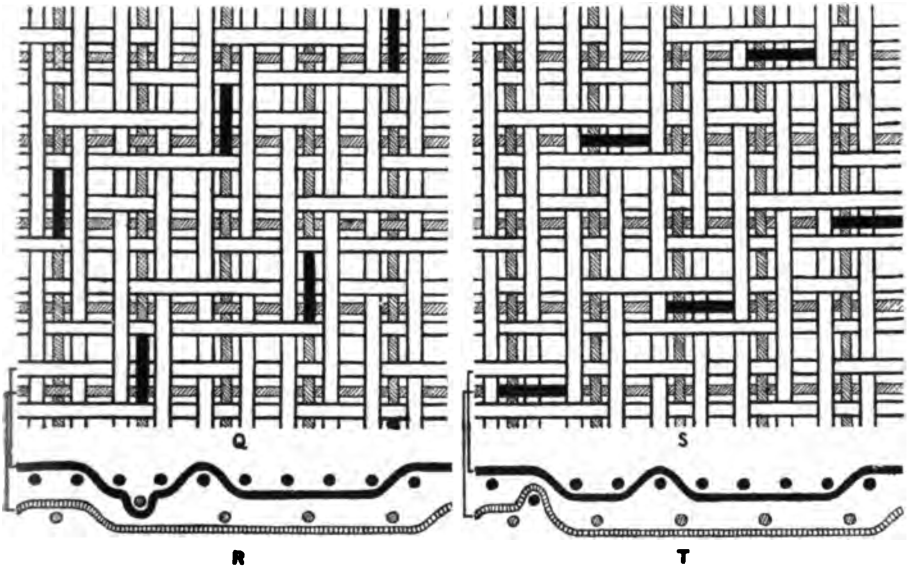


Fig. 25.

It will be seen, from a comparison of Figs. 22 and 24, that in marking for warp the warp stitches are placed between face weave marks (instead of blanks), and the backing weft stitches between blanks in the face weave (instead of marks); while dots are inserted to lift the face ends on the backing picks, except where backing weft stitches are indicated (instead of marking backing ends down on face picks, except where there are warp stitches). L and M in Fig. 24 respectively show the appearance of J and K when only one kind of mark is used to indicate the warp floats, marks being omitted in M to correspond with the crosses in K which represent weft float.

In the flat view given at Q in Fig. 25 the interlacings of the face and backing series of threads and the positions of the warp ties correspond with the marks and blanks in the point-paper plan shown at J or L in Fig. 24. The section R in Fig. 25 shows the interlacing of the first backing pick and the second face pick of S. It will be seen that where the backing warp enters the face cloth for tying it will be concealed by the face warp floats; also, as each backing end (where raised over a face pick for tying) is also raised on the backing pick which precedes and succeeds the tie, the face-weft tie will be covered on the underside of the cloth by the backing-weft floats.

S and T in Fig. 25 respectively show the flat view, and the order of interlacing of the first backing pick and the second face pick of the weave given at K, or M in Fig. 24, in which weft tying is employed. The tie will be concealed on the face of the cloth by the face picks which precede and succeed it, but on the back of the cloth the face warp tie will be covered on one side only by the backing warp. This cannot

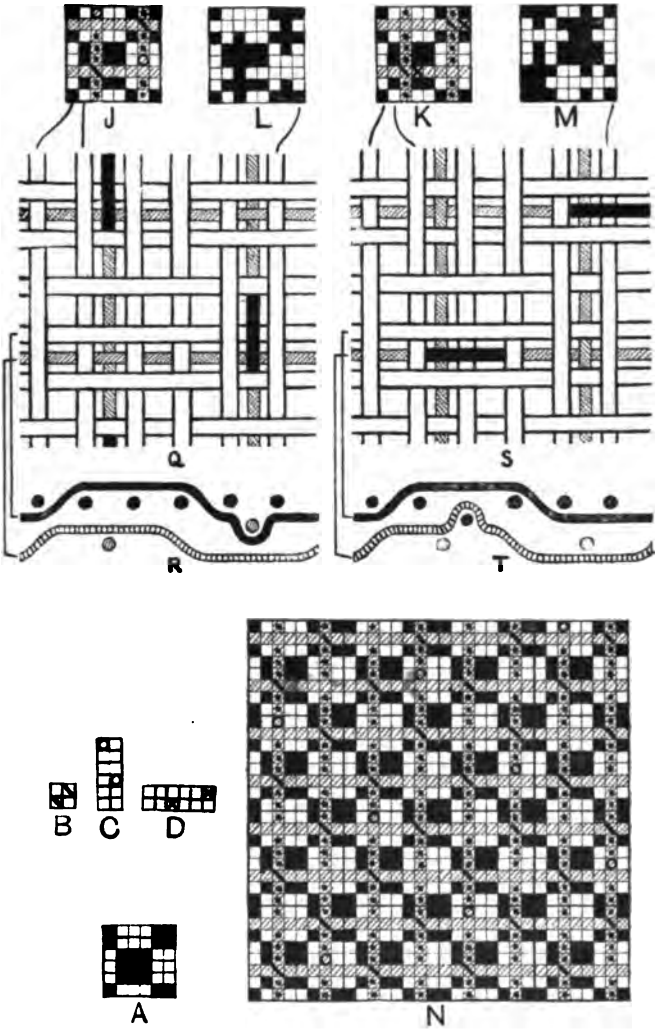


Fig. 26.

be avoided, because, on the underside there is only a warp float of one at a place in the backing weave.

In the following examples (Figs. 26 to 33) the different stages of working are not shown separately, but illustrations which correspond with those given in Figs. 22 and 23, or Figs. 24 and 25, are lettered the same. Thus the face weave is given at A, and the backing weave at B, while C shows the order in which the backing ends are raised over the face picks in warp tying, and D the order in which the backing picks are passed over the face ends in weft tying. The complete double-cloth design

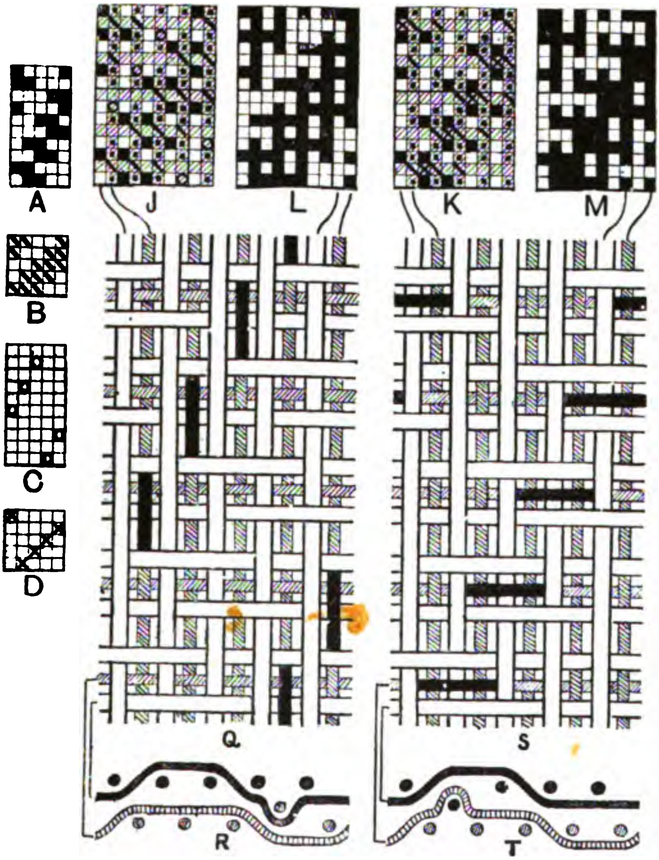


Fig. 27.

showing warp tying, is given at J, and showing weft tying at K, the different stages of working being indicated by the different marks in the following order :—The position of the backing threads is shown by the shaded squares ; the face weave is represented by the full squares ; the ties are indicated by the circles and crosses for warp and weft tying respectively ; the backing weave is shown by the diagonal strokes ; and finally the dots indicate backing ends down on face picks if the weave marks represent weft, or face ends up on backing picks in cases where the weave marks indicate warp. The plans L and M show the appearance of J and K respectively when only one kind of mark is used to indicate the floats. A flat view and section to correspond with warp tying are given at Q and R, and to correspond with weft tying at S and T.

In Fig. 26 the threads are arranged in the proportion of three face threads to one backing thread. This order of arrangement is useful for cloths in which the face fabric is very fine, as, for instance, when face yarns of higher counts than 2/48's worsted are employed; and, usually, the backing weft is thicker than the backing warp and soft spun, in order that softness of handle will be obtained on the underside of the cloth. As shown at A and B respectively in Fig. 26, 3-and-3 hopsack weave is employed for the face fabric, and plain weave for the back fabric, while the warp ties are distributed in plain order on the third and sixth face picks, as indicated at C, and the weft ties in plain order on the third and sixth face ends, as represented at D. With a face weave of this character it is necessary to take into consideration that there will be a tendency for the face ends to run in groups of three. Therefore, they are arranged in the order of 2 face, 1 back, 1 face, and the face weave is inserted in such a position that by denting four or eight ends (including the backing ends) through each split of the reed, the grouping of the ends is neutralised, and the face of the cloth is made as uniform as possible.

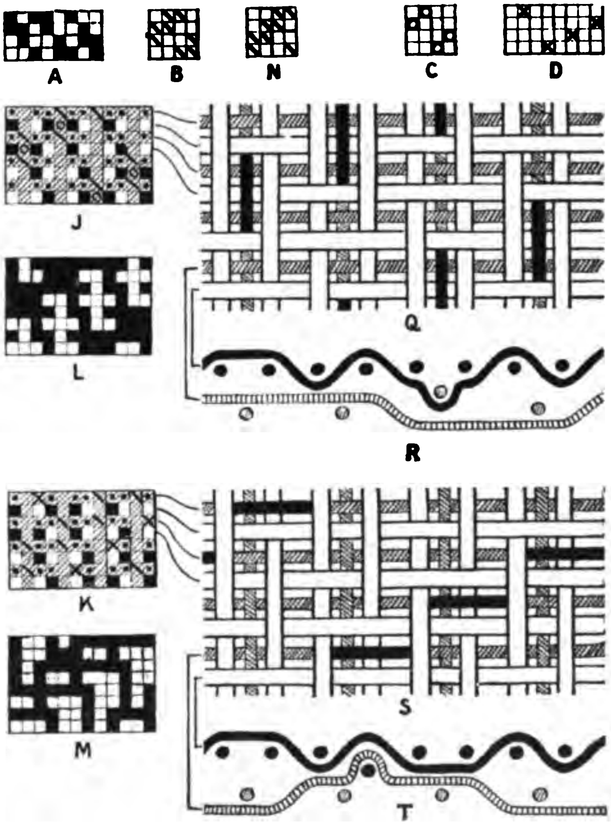


Fig. 28.

In Fig. 26 the weave marks, with the exception of the circles, indicate *weft*. The sections R and T represent the interlacing of the third face pick and the first backing pick of the respective flat views. In both methods of tying the stitches are effectively covered on the face of the cloth but only partially on the underside.

The design N in Fig. 26 is introduced, in addition to J and K, in order to show how the ties (warp tying is illustrated) may be distributed in 8-sateen order. This arrangement of the ties may be employed with advantage for a cloth in which the two fabrics do not require to be so firmly united as is the case with the alternate order of tying. The distribution of the ties over the surface of the fabric is perfectly uniform in the design N.

Fig. 27 shows the construction of the plan for a double cloth, the threads of which are arranged in mixed order, the proportion being 1 face to 1 back in the warp, and 2 face to 1 back in the weft. The arrangement is specially suitable for a cloth in which fine warp yarns, closely set, are required for both the face and back fabrics, and thicker weft yarns (particularly on the underside), with less picks than ends per inch. The repeats of the face and backing weaves (A and B respectively) fit with the arrangement of the threads. The backing warp ties (indicated at C) are placed only on alternate face picks, whereas the backing weft ties (shown at D) engage all the face ends. The weave marks indicate *weft*, with the exception of the circles. The sections R and T show how the first face pick and the first backing pick of the corresponding flat views interlace. The face and backing weaves are so placed in relation to each other that the ties are in the best position for being concealed on both sides of the cloth by the adjacent floats.

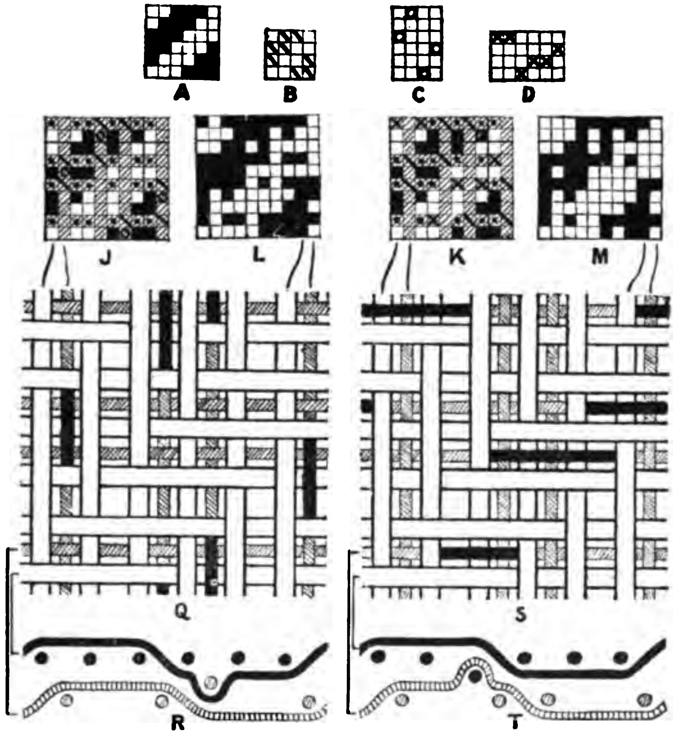


Fig. 29.

In Fig. 28 the working out of the point-paper plan is shown for a double cloth, in which the threads are again arranged in mixed order, the proportion in this case being 2 face to 1 back in the warp, and 1 face to 1 back in the weft. This order of arrangement is specially applicable to face weaves which repeat on twice as many ends as picks. The 2-and-2 twill, cut every two ends, is employed for the face fabric, 2-and-2 twill for the back fabric, and the tying is effected in 4-thread twill order.

The weave marks indicate *warp*, with the exception of the crosses which represent backing weft stitches. This is an example in which the back weave is looser than the face weave, taking into account that there are fewer ends on the underside than on the face. In order to enable suitable positions to be selected for warp tying, the face weave is so placed that a backing end comes between the two ends which twill with each other, and not between two which cut. In warp tying the ties are effectively covered on both sides of the cloth by the adjacent floats, but in weft tying, in order that the ties will be perfectly covered on the back of the cloth as well as on the face, it has been necessary to change the position of the backing weave to that shown at N in Fig. 28.

Fig. 29 shows the working out of the plan of a double cloth, in which the threads are arranged irregularly in the proportion of 6 face ends and picks to 4 backing ends and picks. In this principle the face fabric may be made finer than the back fabric in almost any required proportion. The chief point to note is that suitable weaves are selected for the face and back fabrics respectively. Thus, if the threads are arranged 5 face to 4 back, a 5-shaft face weave should be combined with a 4-shaft backing weave ; if 4-face to 3 back, a 4-shaft weave with a 3-shaft weave, or an 8 shaft weave with a 6-shaft weave ; if 9 face to 7 back, a 9-shaft weave with a 7-shaft weave, etc. In the example 3-and-3 twill is employed for the face fabric, and 2-and-2 twill for the back fabric, and as the face fabric is finer than the back fabric in the proportion of 6 threads to 4, the 3-and-3 twill face will be similar in appearance to the 2-and-2 twill back. The cloth will therefore have the semblance of a double 2-and-2 twill, but its wearing property will be superior on account of the greater fineness of the face fabric. In the warp method of tying, illustrated in Fig. 29, no tie is placed on the second and fifth face pick, but in the weft method a slight deviation from the ordinary system is illustrated. The even backing picks pass over two face ends, while the odd backing picks only pass over one. They are arranged in this way in order that all the face ends will be intersected by the backing picks, and to show one method of obviating the difficulty which frequently arises in weaving when only a portion of one series of ends is employed for tying. If, however, there is any liability of the ties showing on the surface of the cloth, such a method should not be employed.

Construction of Double-Cloth Designs for Looms with Changing Boxes at One End Only.—If the same kind of weft yarn be used for both the face and back fabrics, the method of constructing the point-paper plan is not affected by the limitation in the boxing capacity of the loom, even though, as is sometimes the case, two or more shuttles are employed for the purpose of obtaining a more regular cloth. If, however, the backing weft is different from the face weft, it is necessary for the face and backing picks to be arranged on the point-paper to alternate with each other in even numbers acording to the relative proportions required. The arrangement of the face and backing ends may be the same as in ordinary double-cloths, and it is better that it should be the same, for if the backing warp be employed for tying, the placing of the ties is then not influenced by the order in which the picks are inserted, so far as the face of the cloth is concerned. The covering of the corresponding face weft ties on the underside of the cloth is, however, not so easily effected when the picks are arranged in even numbers. The backing weft should only be employed for tying when absolutely necessary, as the insertion of the picks in even numbers not only renders it more difficult for suitable tying positions to be selected in the majority of face weaves, but the interweaving of the backing weft with the face warp at intervals of 2 or 4 face picks, increases the tendency of the latter to group in 2's or 4's.

The system of construction is exactly the same as in the foregoing designs. In Fig. 30 the face and backing threads are arranged in equal proportions, the ends in the order of 1 face 1 back, and the picks in the order of 2 face 2 back. The weave marks in Fig. 30 indicate weft with the exception of the circles which represent the backing-warp stitches. The 2-and-2 twill weave is employed for the face fabric, but for the back fabric the 1-and-3 warp twill, shown at B, is used for warp tying, and the 1-and-3 weft twill, shown at N, for weft tying. Hence with the design J or L the underside of the cloth will have a weft surface, and with the design K or M a warp surface.

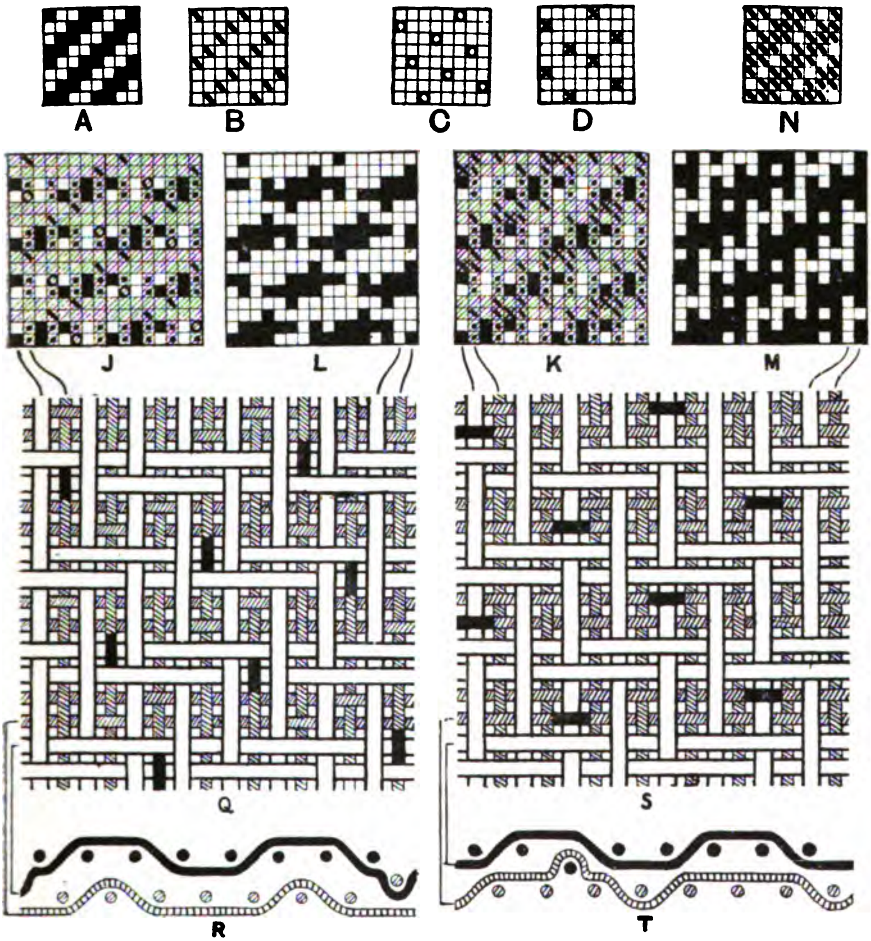


Fig. 30.

In the flat view given at Q the warp ties are shown arranged in 8-thread sateen order, as indicated at C, and it will be observed that on the face side of the cloth each tie is placed between two face warp floats. Also each backing end is raised on the backing picks which precede and succeed a tie, hence on the underside of the cloth each face weft tie occurs between two backing-weft floats. R in Fig. 30 represents the interlacing of the second face pick and the first backing pick, from which it will be seen that the face ends and the backing picks are quite separate and distinct from each other, while the face picks interweave at intervals with the backing ends (in this case the eighth backing end) for the purpose of uniting the two fabrics.

In the weft method of tying, illustrated in the flat view S in Fig. 30, on account of the picks being inserted in pairs, there are no positions available for passing the backing picks over the even face ends with a face weft float on both sides. The ties can therefore only be placed on the odd face ends, and though they are equally as well covered on both sides of the cloth a comparison with Q will show that the distribution is less perfect in this system than when the backing warp is employed for tying. Because of the difference in the arrangement of the ties the design J repeats upon twice as many picks as the design K, of which two repeats are shown. In the section given at T the face picks and the backing ends are shown quite separate from each other, the union of the two fabrics being effected by the backing weft interweaving at intervals with the face ends.

The threads in Fig. 31 are arranged in the proportion of 2 face to 1 back in warp and weft, the ends in the order of 1 face, 1 back, 1 face, and the picks in the order of 4 face, 2 back. In this case also wett is indicated, and for the face fabric the 5-thread weft Venetian weave A is employed for both warp and weft tying. For the back fabric the 5-thread twill given at B is employed for warp tying, and the 5-thread Venetian (with the warp on the underside) given at N for weft tying. The former backing weave is firmer than the latter, and also than the face weave, and may therefore be used when the back fabric is composed ot fine yarns. On the other hand, the fewer intersections of the backing weave shown at N render it suitable for a cloth in which thicker backing than face yarns are employed. It should be noted that on account ot the backing picks being inserted in pairs it is necessary for the 5-pick backing weave to extend over 10 backing picks, hence 20 face picks are required. The complete design therefore repeats on 30 picks. In both methods of tying, the ties are placed between corresponding face floats, but on the underside of the cloth some ot the ties have a corresponding float on one side only. Thus, from an examination of the flat view S in Fig. 31, it will be seen that the face ends, which are passed over by the even backing picks, have a backing warp float on one side, and a backing weft float on the other side.

In Fig. 32 the threads are arranged in mixed order, the proportions being 2 face to 1 back in the warp, and 2 face to 2 back in the weft. Warp is indicated in the plans, and the 5-thread warp-face Venetian weave A is employed for the face fabric, and the 5-thread sateen, with the weft on the underside, for the back fabric. Weft tying is not illustrated in the figure, but two methods of distributing the warp ties are given at C and N. The corresponding complete plans are shown at J and O, while the design given at L corresponds with J. With the ties distributed as shown at C and J, the alternate face picks only are passed over by the backing ends, and although this is a standard method of distributing the ties for cloths in which the face and backing ends are in the proportion of 2 to 1, in many cases it is found that a more even cloth is formed if all the face picks are employed for tying, as then the shrinkage of each is the same. The diagrams Q and R correspond with the design J.

The diagram P in Fig. 32 corresponds with the design O and is similar to Q

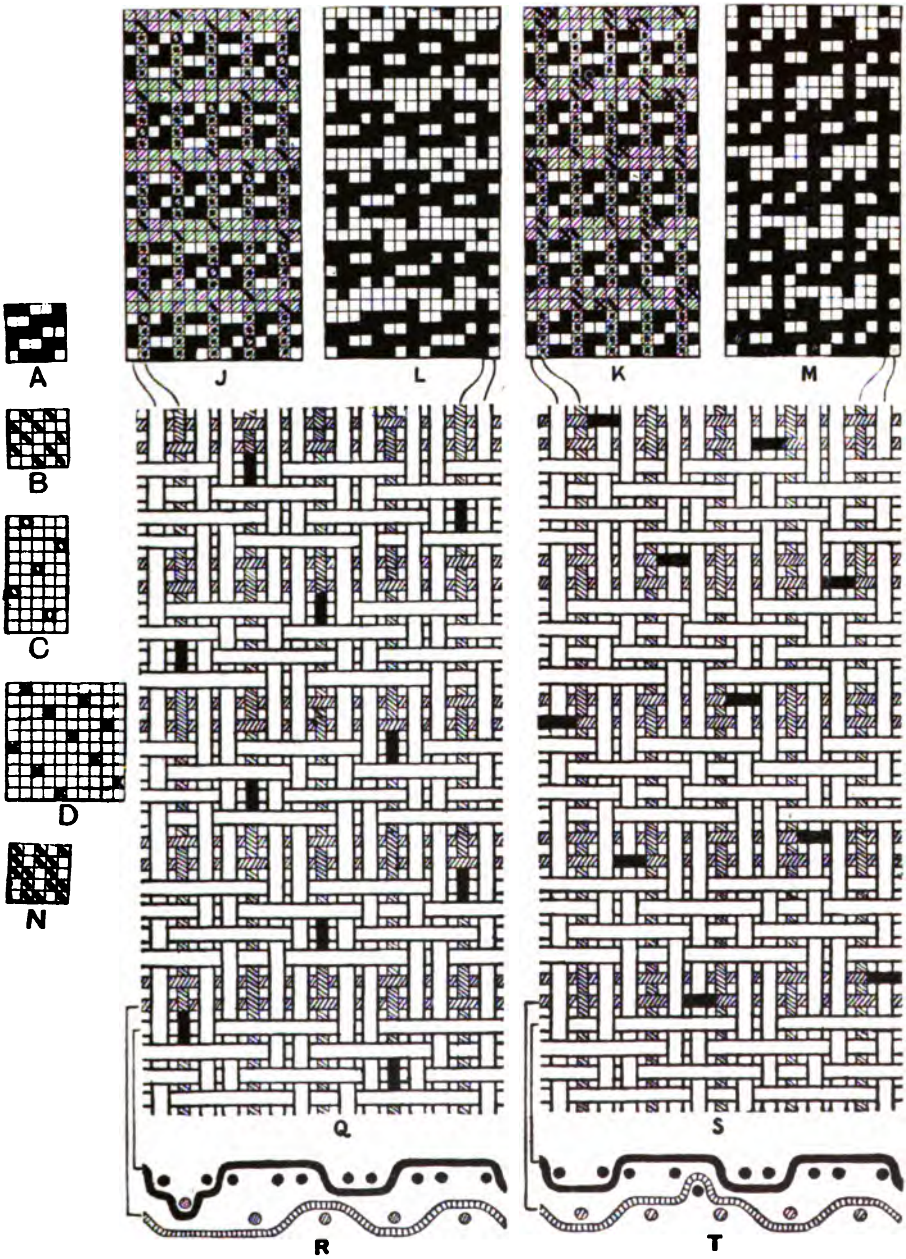


Fig. 31.

except that in this case all the face picks are passed over by the backing ends. With the latter order of tying the two fabrics will not only be more firmly united, but the shrinkage of the weft picks will be uniform. The distribution of the ties in this order will, however, be liable to produce an indistinct twill running in the opposite direction to the face warp twill, which, by detracting from the clearness of the latter, may be a source of defect.

Although it is not advisable for the face and backing ends to be arranged with each other in even numbers, as the difficulty of tying the two fabrics satisfactorily together is thereby increased, circumstances sometimes arise which render the arrangement necessary, hence for the purpose of illustration, an example is given in Fig. 33 in which the threads are in the order of 2 face, 2 back, in both warp and weft. The 2-weft, 3-warp twill is employed for both the face and back fabrics. In both the warp and weft methods of tying the ties are distributed regularly in such a manner that the same number is placed on each thread, while each tie is con-

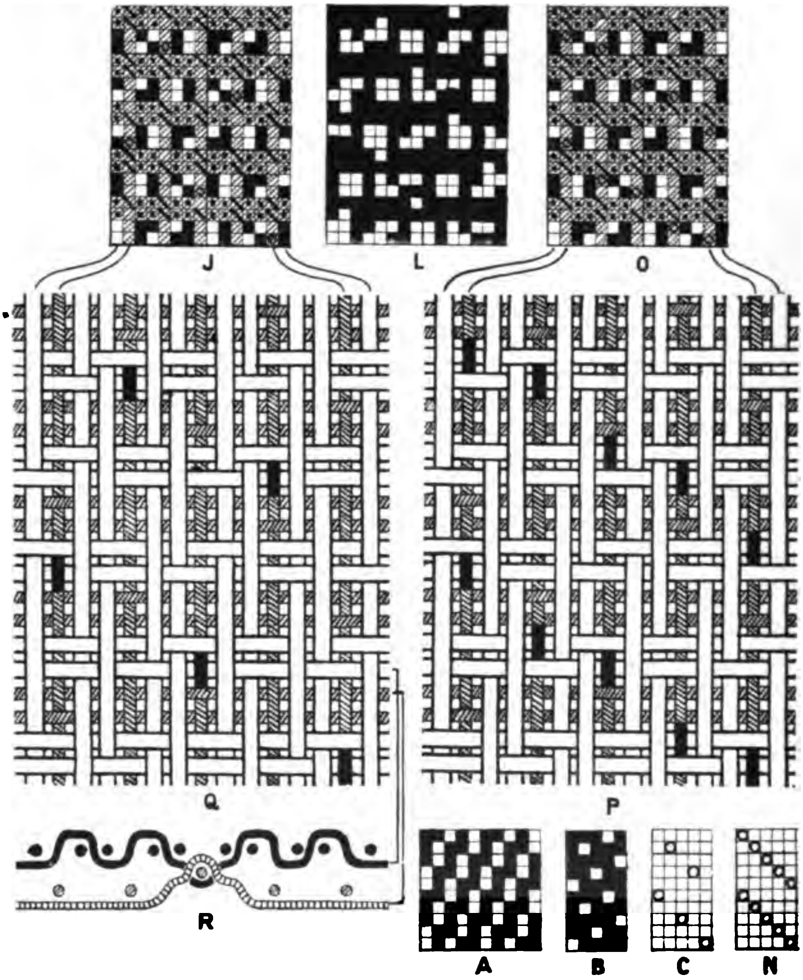


Fig. 32.

cealed on both sides of the cloth by the adjacent floats. It is due to the weave which is used for the face and back repeating on an odd number of threads that such a correct distribution of the ties is possible ; a twill weave repeating on an even number of threads can not be tied so satisfactorily in the 2-and-2 arrangement. The weave marks in Fig. 33 represent weft with the exception of the circles.

Double-Cloth Beaming, Drafting, and Pegging.—As in warp-backed cloths (see p. 15), if the yarns for the face fabric are similar to those for the back fabric, and the intersections of the weaves are relatively the same, it is possible for a perfect double-cloth to be woven with only one warp beam. An example of such a double weave is illustrated in Fig. 34, in which the same weave—shown at A and B—is used for the face and back fabrics, while both series of threads are used for tying, as indicated at C. In the plan C the circles denote backing ends passing over face picks, and the crosses backing picks passing over face ends, the cloth being double-stitched.

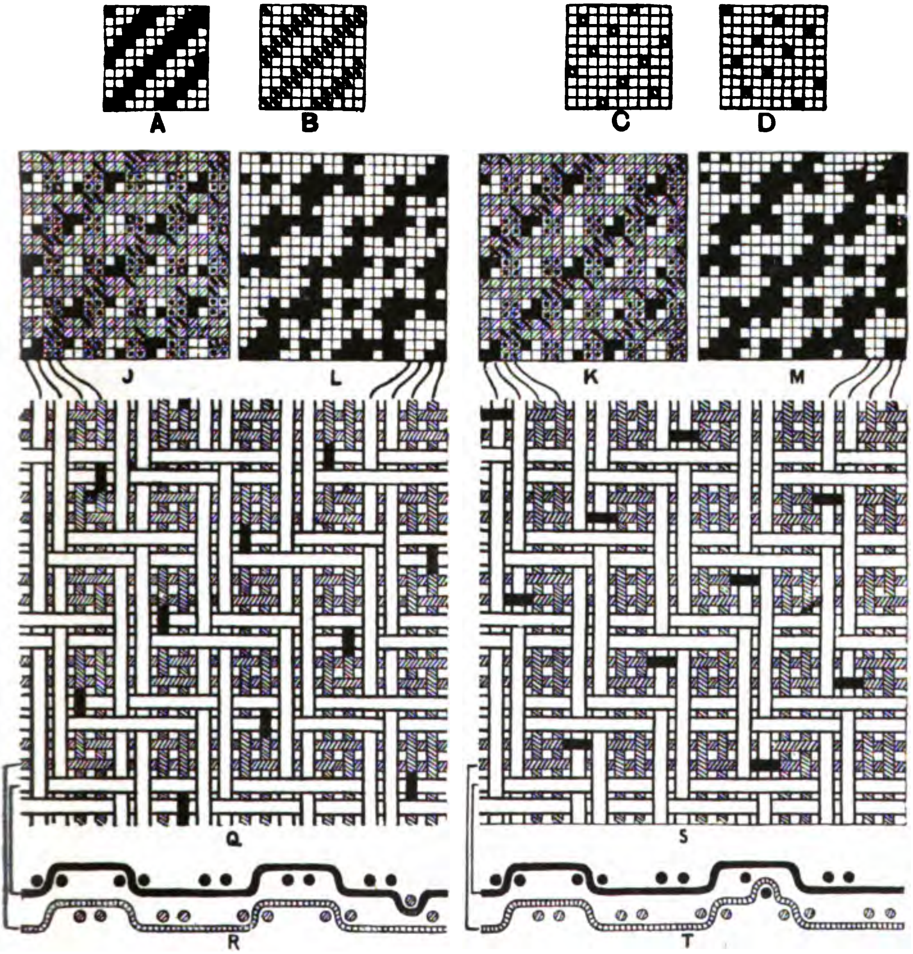


Fig. 33.

In the complete design, given at D, the weave marks indicate warp, with the exception of the crosses. The corresponding flat view is shown at E, while F represents the interlacing of the first face and the first backing end. It will be seen that the relative number of intersections is the same for each thread; hence, if the yarns in each fabric are similar, the contraction of the warp threads in weaving will be uniform, and the equal tension required for each series will be better obtained by using only one beam. If, however, the face yarns in a cloth are different from the backing yarns, or, on the other hand, if the weaves are different as regards the relative number ot intersections, it is better for two warp beams to be used, in order that the two series of threads may be separately tensioned. As a general rule two beams are employed, and the proper tensioning of the two warps is then of great importance, because if the backing warp is held tighter than the face warp the backing warp stitches are liable to impair the softness of handle of the cloth, while if it is slacker the cloth is deficient in soundness. Normally, the two warps should be held at about the same tension.

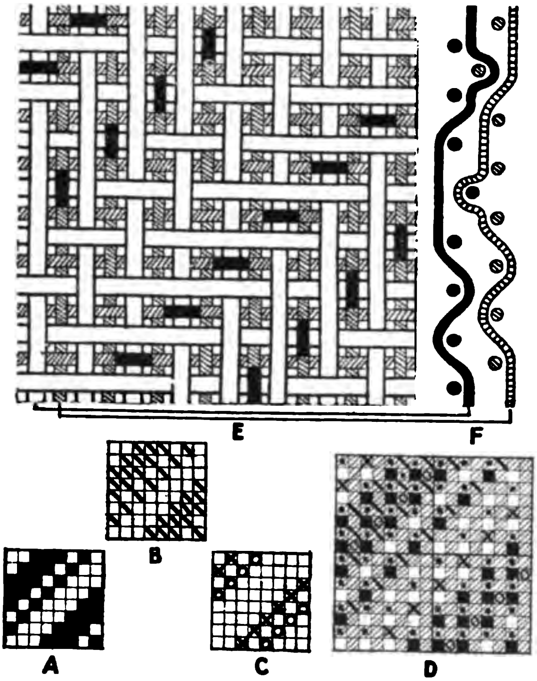


Fig. 34

In the drafting of double-cloths the conditions are very much the same as in warp-backed cloths (see p. 15). Thus, the double 2-and-2 twill design given at D in Fig. 35 (the face weave of which is shown at A, the backing weave at B, and the order of warp stitching at C) may be drafted in one of the methods illustrated at E, F, and G. At E the backing healds are shown intermingled with the face healds, whereas at F they are shown in front of, and at G behind the face healds.

With the exception that a set of healds is required for each fabric, the ordinary method of constructing a draft may be employed—*i.e.*, the threads in each fabric which work alike may be drawn on the same heald. Therefore the minimum number of healds in each set is decided by the number of threads in each fabric, which work different from each other. Thus, the design D in Fig. 35 requires eight backing healds, although the backing weave is on four threads, because the backing ends must be raised for tying independently of each other in the 8-thread sateen order given at C. Only four face healds are required, because the working of every fourth face end is the same. This will be understood from an examination of the flat view given at M in Fig. 36, which corresponds with the design D in Fig. 35, and the section, shown at N, which represents how the first face and the first backing end interlace.

The face ends work regularly in 2-and-2 order with the face picks, whereas the backing ends, in addition to working in 2-and-2 order with the backing picks, are raised for tying in 7-and-1 order with the face picks.

H, I, and J in Fig. 35, in which different marks are used to distinguish the face

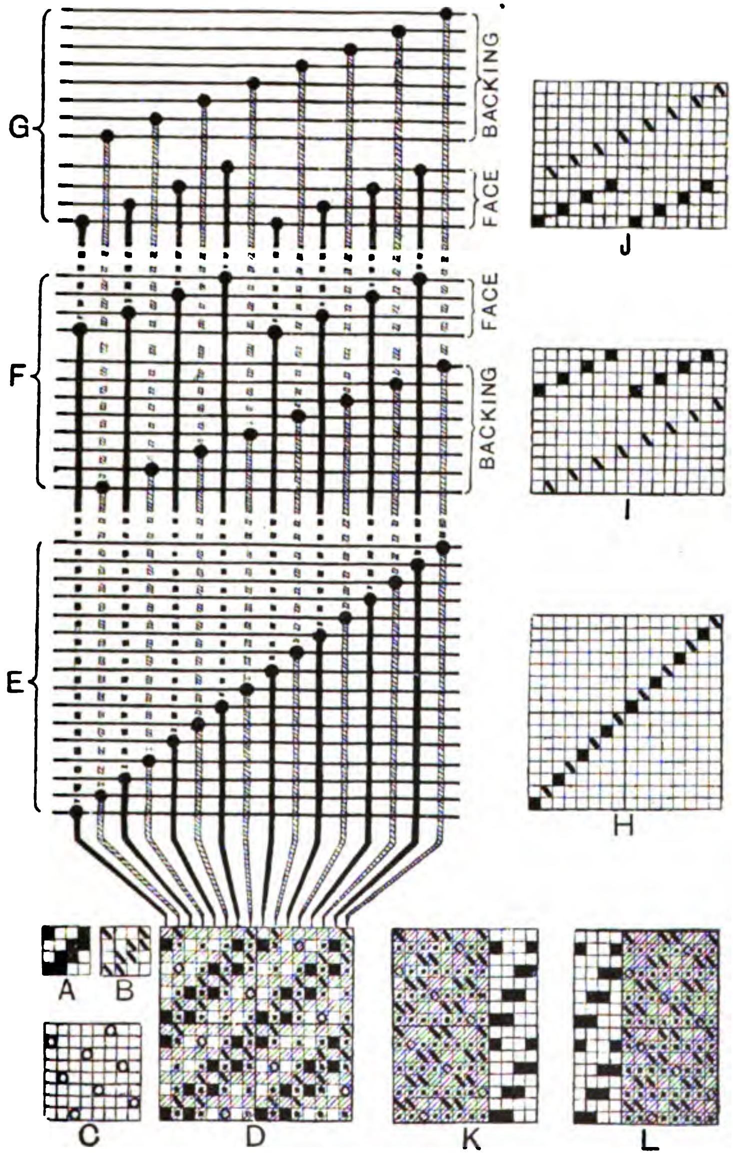


Fig. 35.

ends from the backing ends, respectively show the more convenient method of indicating the drafts given at E, F, and G on point-paper. When the face and backing healds are intermingled it is convenient to employ as many healds as there are ends in the repeat of the design, as shown at E and H. Also, when a special draft such as I or J is used, the draft may be made upon the same number of face as backing healds (see G in Fig. 13, p. 14), in order to give more scope in varying the weaves, and so that the healds will all be equal in fineness.

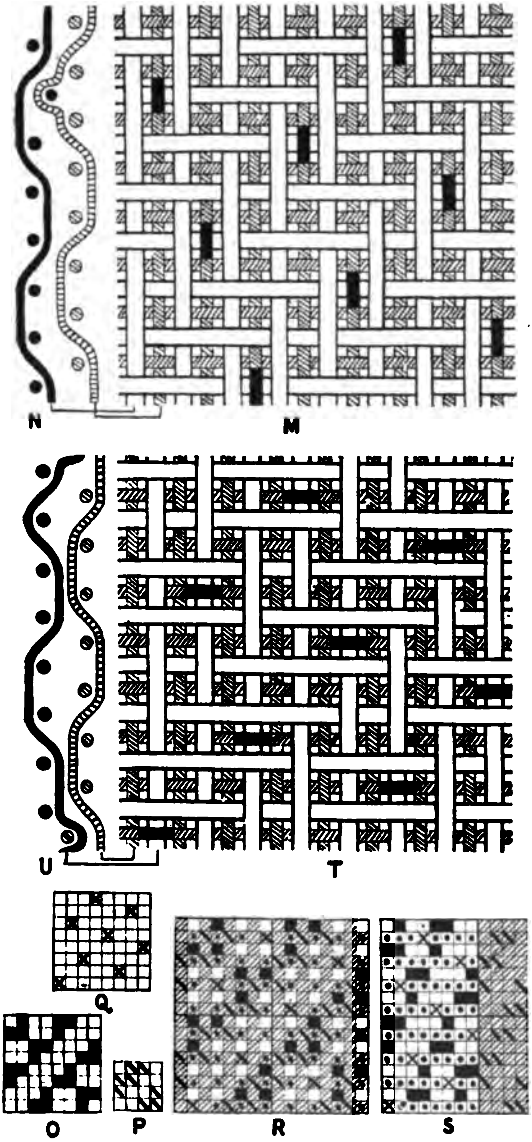


Fig. 36.

The pegging plan may be made in the ordinary manner by copying from the double weave the working of the healds, commencing with the first and taking them in consecutive order. The number of squares in the repeat on the point-paper is equal in one direction to the number of healds, and in the other direction to the number of picks in the double weave. In Fig. 35, D is not only the design, but also the pegging plan for the straight draft given at E, while K and L are the pegging plans for producing weave D on the drafts shown at F and G respectively. In each case the working of the backing healds is indicated on the shaded squares which, it will be seen, coincide in position in the pegging plans with the position which the backing healds occupy in the draft. Thus, in plan K they precede and in plan L follow the vertical spaces on which the working of the face healds is indicated. Weft is represented in the design D, so that the marks in the pegging plans (with the exception of the circles) indicate healds down.

Sometimes it is convenient for the healds which have been used for the back fabric in a design to be subsequently employed as the face healds, and *vice versa*, in order that a change in the weave, or in the method of tying may be made without redrawing the warp. For example, if a face end be twisted to a backing end, the drafts given at F and G in Fig. 35 may be employed for a double-cloth in which the eight-shaft face weave shown at O in Fig. 36 is combined with the 4-shaft backing weave given at P. As, however, there will then be only four backing healds, it is impossible to effect the tying in 8-end order by means of the backing warp; but as there are eight face healds, the face ends may be depressed for tying independently of each other in the 8-end sateen order given at Q in Fig. 36. The complete double weave is shown at R, and S is the pegging plan for producing R on the draft given at F in Fig. 35, the front eight healds of which are now used for the face ends, and the four back healds for the backing ends. In this example warp is indicated so that the marks in S (with the exception of the crosses) represent healds raised. The flat view and a section showing the interlacing of the first backing and the first face end are given at T and U in Fig. 36. A comparison of M and N with T and U in Fig. 36 will show that when warp tying is employed, the backing ends are affected, so that the number of backing healds must be at least equal to the number of different tying positions in one repeat of the tying plan; while in the case of weft tying, the face ends are affected, hence the minimum number of face healds is indicated in the same way.

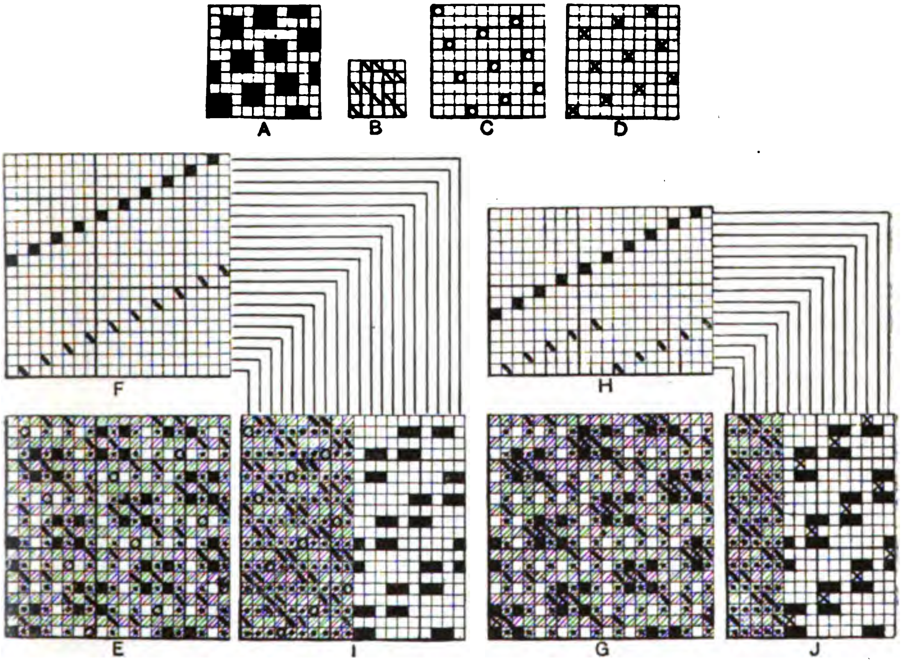


Fig. 37.

Effect of the System of Tying upon the Number of Healds.—When a fancy weave is employed for the face fabric, and a smaller weave for the back fabric, it will frequently be found that fewer healds are required for weft tying than for warp tying. For example, assuming that in a 1-and-1 double-cloth the weave shown at A in Fig. 37 is employed for the face fabric, and that shown at B for the back fabric, ten healds will be required for the face weave, and five healds for the backing weave, without taking the question of tying into consideration. With weave A either warp or weft tying may be employed, but the ties can only be distributed satisfactorily in the 10-thread sateen order shown at C or D in Fig. 37. For warp tying E is the double weave, and F the draft, ten backing healds being required in order that the backing ends may be raised for tying in the order given at C. For weft tying, G is the double weave and H the draft, only five backing healds being required in this case, while the the ten healds which are required for the face weave enable the face ends to be depressed for tying in the 10-thread sateen order given at D. Hence, as a total of twenty healds is necessary for warp tying, compared with fifteen healds for weft tying, the latter is the more economical method so far as the number of healds is concerned. The pegging plans for E and G are given at I and J respectively in Fig. 37 and as weft is indicated in the designs the marks in I and J (with the exception of the circles in I) represent healds down.

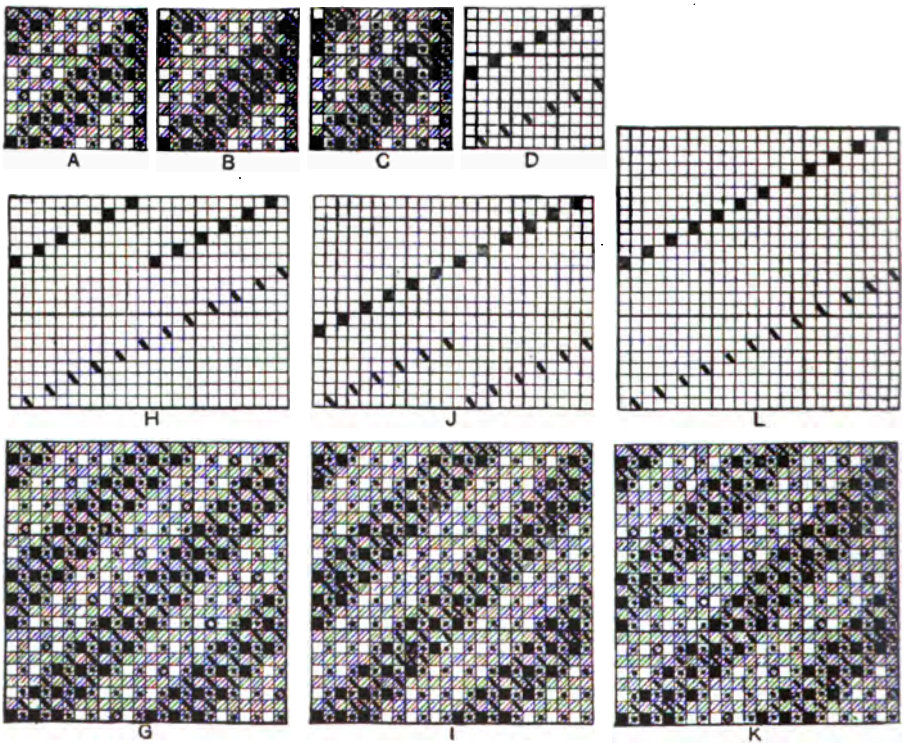


Fig 38.

Fig. 38 illustrates the effect that the system of tying has on the total number of healds, and also on the relative number of face and backing healds when simple weaves are used for both fabrics. The 3-and-3 twill weave is employed for the face and back, and the threads are arranged one face one back in warp and weft—weft is indicated in the plans. If the ties are distributed in twill order, six face and six backing healds will be required, as shown in the draft given at D, for either warp tying, shown at A, weft tying, shown at B, or double tying, shown at C. If, however, the ties are distributed in 12-thread sateen order—for warp tying, shown at G, six face and twelve backing healds will be required, as drafted at H; for weft tying, shown at I, twelve face and six backing healds, as drafted at J; while for double tying, shown at K, it will be necessary to employ twelve face and twelve backing healds, as drafted at L. The double 3-and-3 twill may thus require a total of twelve, eighteen, or twenty-four healds, according to the system of tying which is employed.

A further illustration of the effect of the system of tying on the draft is given in Fig. 39. In this case the threads are arranged in the proportion of two face to one back in warp and weft, while the 2-and-2 twill weave is employed for the face fabric, and plain weave for the back fabric. Weft is indicated in these examples also. The plain order of tying by means of the backing warp is given at M, and by means of the backing weft at N, for either of which four face and two backing healds are required, as shown in the draft given at O. The pegging plans for M and N are given at P and Q respectively. With the 8-thread sateen order of tying by means of the backing warp, shown at R, four face and eight backing healds are required, as indicated at S; while with the same order of tying by means of the backing weft, as shown at T, ten face and two backing healds are necessary, as represented at U. The latter order of drawing in the threads is, however, more complicated than the former. If the tying is affected in 8-thread sateen order by means of both warp and weft, as shown at V, ten face and eight backing healds are required, as drafted at W. The system of tying may thus render it necessary to employ a total of either six, twelve, or eighteen healds in this case.

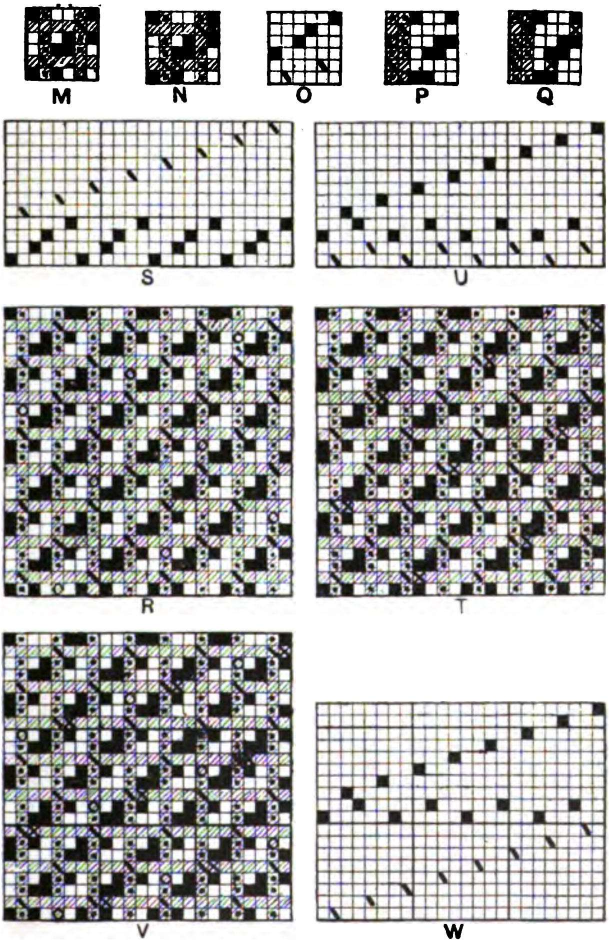


Fig. 39

Special Features in Double-Cloth Designing.—In arranging the order of the ties it is important that the same number be placed, whenever possible, on each end and each pick of the series which is employed for tying. Tying with the backing warp is equivalent to tying with the face weft, while tying with the backing weft is equivalent to tying with the face warp. In the former case the best results are obtained if the backing ends are raised equally over every face pick, and in the latter if the backing picks are passed equally over every face end. In the 1-face 1-back arrangement of the threads this can usually be accomplished without much difficulty, except that all the ties cannot be perfectly concealed in the case of such a face weave as the one shown at A in Fig. 40. The complete cut which occurs in the weave between the second and third and the sixth and seventh ends and picks makes it impossible for the second and sixth backing ends or picks to be passed over the face picks or ends with a corresponding face float on both sides. In an example such as this, however, unless there is a considerable degree of contrast between the face and backing yarns, it is better for a tie to fall on each thread of the series which is employed for tying rather than to select only those positions where the ties will be covered on both sides. C in Fig. 60 shows how the ties may be arranged for warp tying, while at D the complete double weave is shown, the 4-thread twill given at B being used for the back fabric. The weave marks indicate warp. The flat view of the structure is represented at E in Fig. 40, and the interlacing of the fourth face and the fourth backing pick at F. It will be seen that the ties on the fourth and eighth face picks are only covered on one side by the face warp. However, as there is the same number of ties on each backing end and each face pick, the take up in weaving will be the same for each end, and the contraction in width the same for each pick. A more regular cloth will therefore be produced than would be the case if no ties were placed on the second and sixth backing ends.

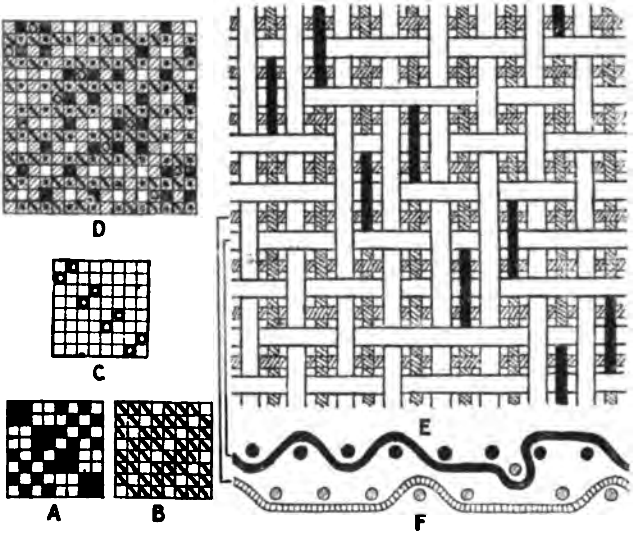


Fig. 40.

When the threads are arranged in unequal proportions it is frequently impossible for the same number of ties to be placed on each face thread, although it is usually an easy matter to place the same number on each backing thread. Thus, in the standard methods of tying the 2-face to 1-back arrangement, usually only half the face picks are passed over when the backing warp is employed, and only half the face ends in the case of the backing weft. For instance, the warp ties for the Mayo weave, given at G in Fig. 41, are usually distributed as shown at I, the alternate face picks only being passed over by the backing ends. J shows the complete design with the 2-and-2 twill, given at H, as the back weave, the marks indicating warp. The corresponding flat view of the structure is represented at K in Fig. 41. However, by changing the position of the face weave to that shown at L, so that it is situated in relation to the backing threads, as indicated at O in Fig. 41, it is possible for the ties to be distributed as represented at N. In this case, as shown in the design O (for which M is the backing weave) and the corresponding flat view given at P, a tie is placed upon each face pick. In the repeat of the double weave, however, each backing end is stitched twice to the face texture.

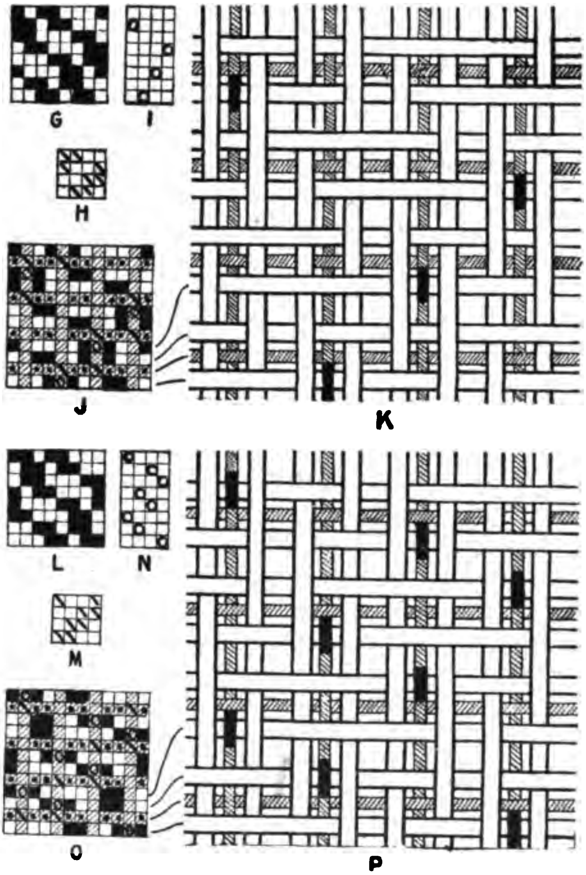


Fig. 41.

The flat view given at V in Fig. 42 shows the standard method of distributing the ties in the 2-and-1 arrangement when weft tying is employed. The corresponding face weave is given at Q, the backing weave at R, and the order of tying at S. When the even ends only are passed over by the backing picks, they will, in ordinary weaves, be liable to take up in weaving more rapidly than the old ends. This weave, however, is exceptional in the fact that the odd face ends interweave more frequently with the face picks than the even face ends, there being four intersections in eight picks in the former, compared with two intersections in the latter. This is shown in the section given at W in Fig. 42, in which the dotted line shows the interweaving of the first face end, the solid black line of the second face end, and the shaded line of the first backing end. The placing of the ties on the looser woven ends will tend to neutralise the variation in the take-up caused by the difference in the number of intersections between the odd and even ends. The distribution given at V in Fig. 42 will therefore yield the best results in weaves of this character. However, in order to illustrate a method of stitching on every face end, the flat view is extended to another repeat of the weave, as shown at X in Fig. 42, the ties being placed on the odd ends in the second repeat in order to balance those which are placed on the even ends in the first repeat. The plan of the ties for the two portions lettered V and X is given at T in Fig. 42, while the complete double weave is shown at U.

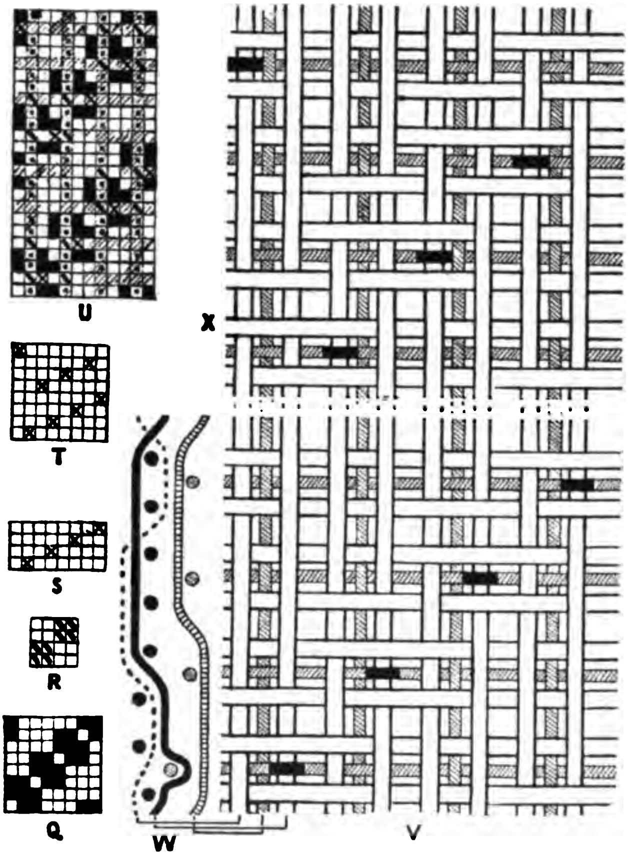


Fig. 42.

When the floats of the face weave permit it, this method of distributing the ties may be adopted with advantage for ordinary weaves. The difficulty which is frequently found in the 2-and-1 arrangement, of placing a tie on each face end, is one reason why tying with the backing weft is usually not so suitable as tying with the backing warp. It is better to have the ties unevenly distributed on the face picks than on the face ends, so far as the weaving of the cloth is concerned.

In order that a regular cloth may be obtained, the backing weave should be suitable for the back fabric, and similar to the face weave. Thus, the loose face weave given at Q in Fig. 42 is backed with the 2-and-2 hopsack weave shown at R.

This combination will permit of the use of thick backing yarns and yield a soft under texture.

When a twill weave is employed for the face fabric and the ties are distributed in twill order, they should fall equally on each face warp twill in the case of warp tying, or each face weft twill in the case of weft tying. If they fall on alternate twills only, as shown in the double-cloth design given at A in Fig. 43, and the corresponding flat view represented at B, adjacent twill lines are liable to appear different from each other. The example is a double 1-weft-and-2 warp twill structure, in which the threads are arranged in the order of 1 face, 1 back in warp and weft, the tying being effected by means of the backing warp. By distributing the ties in 9-sateen order, as shown in the design C and the corresponding flat view given at D in Fig. 43, the ties will fall equally on each face warp twill line. In C and D, however, the ties run somewhat distinctly in the opposite direction to the twill of the face fabric, and there is, therefore, a liability of a cross-twill showing in the cloth. (For further reference to this defect see p. 6.)

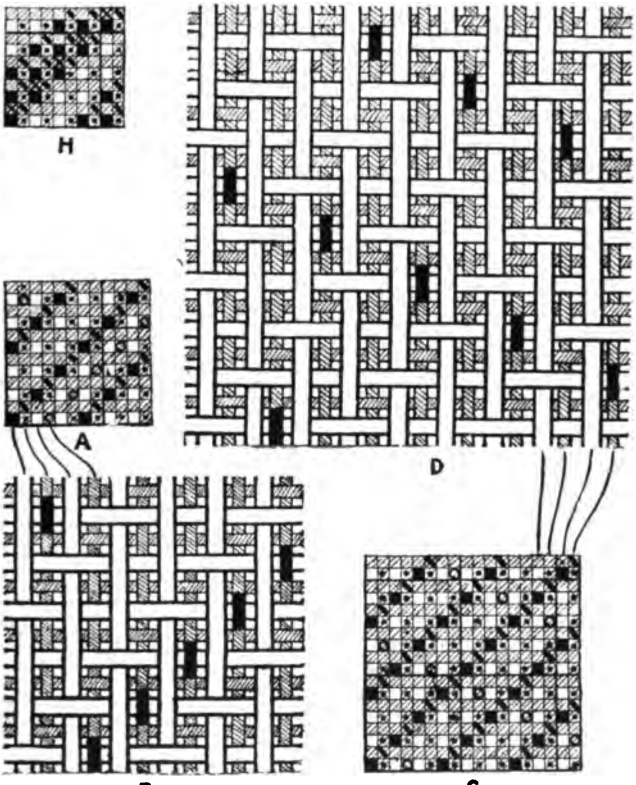


Fig. 43.

The design H in Fig. 43 illustrates that in backing weft tying if there is a choice of two consecutive positions for a tie in the face weave, it is, as a rule, better to select that which will be covered by the greater number of following face picks. The corresponding flat view is given in Fig. 44, on the right of which a section, representing the interweaving of the first face and the first backing pick, is shown. The example is a double 3-weft, 2-warp twill, and the threads are arranged 1 face, 1 back. It will be seen that the weft tie on the first face end may be placed either between the first and second face picks, or the second and third. The former position is shown in the illustrations, and is preferable to the latter, because the beating up of two succeeding face covering picks gives a better opportunity of the tie being concealed.

Position of the Backing Weave.—In the construction of a perfect double-cloth it is necessary for similar conditions to be obtained in the weave of the under-fabric as have been described and illustrated with reference to the weave of the face fabric. The ties form the connection between the two fabrics, and are thus common to both weaves. Therefore, since it is first necessary for the ties to be placed according to the positions of suitable binding places in the face weave, the backing weave should afterwards be suitably placed in accordance with the position of the ties.

There are three positions which a face warp or weft tie may occupy in relation to the floats on the underside of the cloth—viz., between two corresponding floats; with a corresponding float on one side, and an opposite float on the other; and between two opposite floats. Each position is illustrated in Figs. 46 and 47 which correspond with each other in every respect except that the backing warp is employed for tying in Fig. 46, while the backing weft is employed in Fig. 47. The threads are arranged 1-and-1 in warp and weft, and the 2-and-2 twill weave is employed for both the face and the back of the cloth. The weave marks indicate weft, and in the face fabric the 2-and-2 twill is placed throughout as shown at A in Fig. 45, while the ties are placed to suit the face weave as at B for Fig. 46, and as at C for Fig. 47. The backing weave, however, is placed in the three different positions given at D, E, and F in Fig. 45. Thus N in Figs. 46 and 47 shows the flat view of the structure from the face side of the cloth, with the backing weave placed as at D; R with the backing weave placed as at E; and V, with the backing weave placed as at F. Sections O, S, and W respectively show the interlacings of the first face and the first backing pick of N, R, and V. The flat views P, T, and X in each figure correspond with N, R, and V, and show the appearance of the underside when the cloth is turned over horizontally, as indicated by the numbers above the warp threads. Sections Q, U, and Y respectively show the interlacing with their respective picks of the first face, and the first backing end (numbered 1 and 2) of P, T, and X.

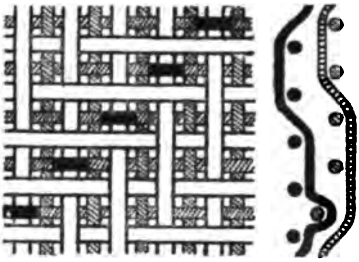


Fig. 44

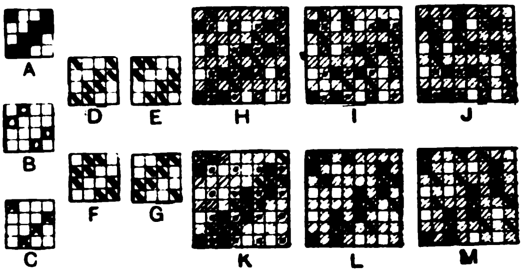


Fig. 45.

It will be noted that in each arrangement the ties will be correctly covered on the face of the cloth by the corresponding face floats between which they are placed. By comparing the flat view N and the section O in each figure with the flat view P and the section Q, it will be seen that with the backing weave placed as at D in Fig. 45, the back of the cloth will be as perfect as the face, because the ties occupy positions between corresponding backing floats. A comparison of R and S with T and U, however, shows that with the backing weave placed as at E, the back fabric will not be so perfect as in the former case, because the position occupied by each tie on the underside is between a corresponding and an opposite backing float. This kind of defect frequently cannot be avoided, as, for example, when a plain backing weave is employed. Although in well-set-up cloths the defect is practically invisible, it should only be allowed to occur when absolutely necessary. A comparison of V and W with X and Y in which the backing weave is placed as at F, shows the most serious defect which can occur in the back fabric. In this case the position occupied by each tie on the underside is between two opposite backing floats. When the backing warp is employed for tying, this causes the warp floats in the underside to be broken by the face weft ties, as shown at Y in Fig. 46, while when the backing weft is employed, the weft floats on the underside are broken by the face warp ties, as shown at W in Fig. 47. This not only results in the ties showing prominently on the underside, but as the intersections of the backing threads are correspondingly increased, the back fabric is made firmer and harder woven than it should be.

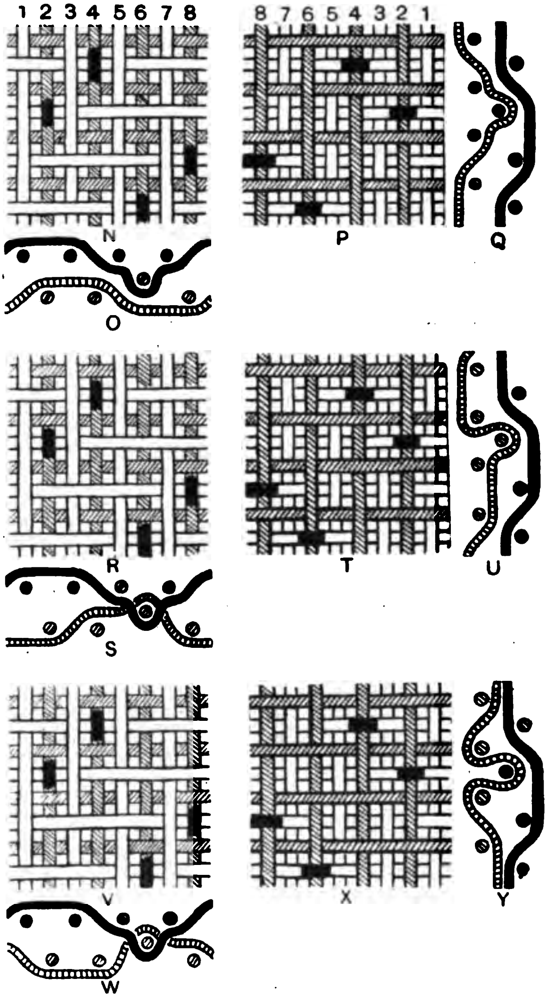


Fig. 46.

The complete plans for the drawings given in Fig. 46 are shown respectively at H, I, and J in Fig. 45, the marks—with the exception of the circles—indicating weft. A comparative examination shows that in warp tying the most perfect back fabric is obtained when each backing end is raised on the backing picks which precede and succeed the face pick on which the tie is placed. In the same way a comparison of the plans given at K, L, and M in Fig. 45, with the corresponding diagrams in Fig. 47, shows that in weft tying the most regular back fabrics results when each backing pick passes over the backing end on each side of the face end on which the tie is placed. (All the marks in K, L, and M indicate weft, but the dots which are shown in K are omitted in L and M.) The backing weave may also be placed as shown at G in Fig. 45, but this will produce a similar defect to that produced by placing it as at E.

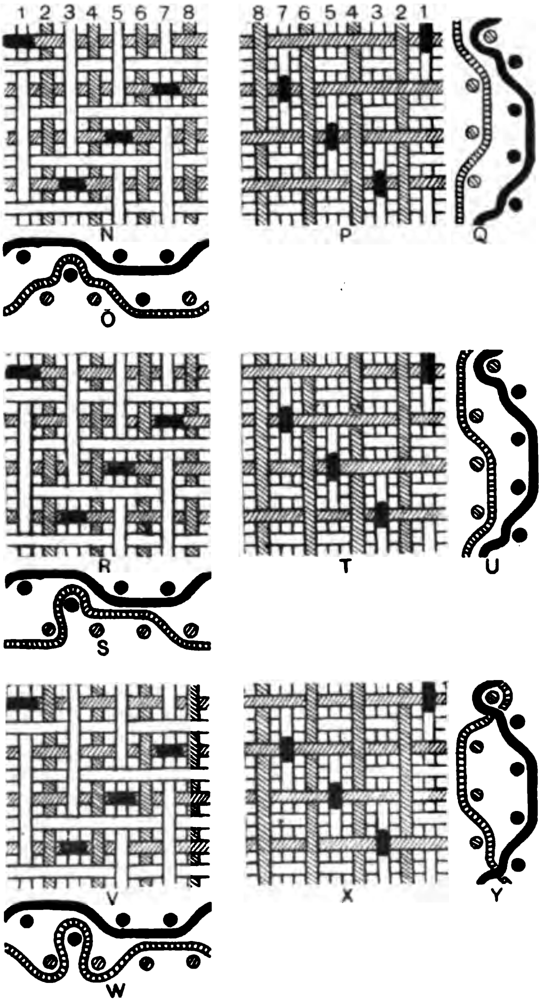


Fig. 47.

For some of the simpler standard makes of double-cloths, in which the ties are distributed in regular order, the position of the backing weave in relation to the ties can be reasoned out without difficulty. Thus, in the foregoing example the best result is obtained with the face and backing weaves occupying corresponding positions, as shown at A and D in Fig. 45. A weft or warp float on the surface of the upper fabric should be above a similar float on the top side of the under fabric, so that where the two fabrics are in contact, a warp float of one is against a weft float of the other. The best conditions are thereby obtained for the interweaving of the warp threads of one cloth with the weft threads of the other cloth. For example, in a 1-and-1 arrangement of the threads, the 4-and-4 twill, shown at A in Fig. 48, may be backed with the same weave in a similar position, as shown at B; while in a 2-and-1 arrangement it may be backed with the 2-and-2 twill in the position shown at C. If the threads are arranged in the proportion of 7 face to 5 back, the 3-and-4 twill in the position shown at D may be backed with the 2-and-3 twill in the position shown at E.

In only the simplest cases, however, may it be safely assumed, without experiment, that the best position of the backing weave has been obtained. Thus, taking F in Fig. 48 as the weave for both the face and the back of a 1-and-1 double-cloth—the marks indicating weft—the warp ties may be either placed as shown in the plan G, or with the same result, so far as the face of the cloth is concerned, they may be placed one pick lower, as shown at H, the marks indicating backing ends raised over face picks. With the ties placed as at G, the most perfect under-fabric will be obtained by commencing the backing weave exactly like the face weave, as shown at I, but with the ties placed as at H, it will be necessary for the backing weave to be changed to the position shown at J in order to secure the best results. In the same way assuming that the weave F is required to be backed with a 2-and-2 twill, K shows the best position of the weave for tying as at G, while L is the best for tying as at H. It is evident, therefore, that the positions of the face weave, the ties, and the backing weave, cannot be decided upon haphazardly, but that they should bear a definite relationship to each other.

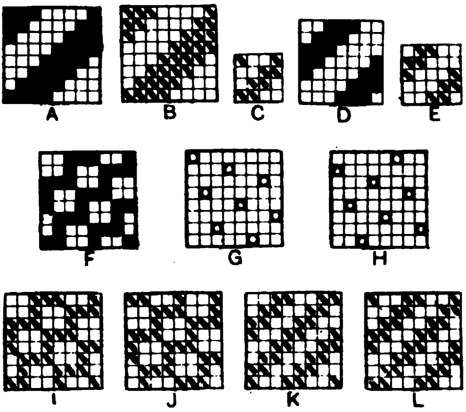


Fig. 48.

Systematic Construction of Double-Cloth Designs.—The example given in Fig. 49 illustrates step by step a convenient method of procedure in constructing double-cloth designs, by which it is possible to ensure that the best conditions will result both on the face and the back of the cloth. It is applicable to any type of face or backing weave, and to any arrangement of the threads. A is the plan of the face weave, which, it may be assumed, is required for a cloth in which the threads are arranged in the order of 1 face, 1 back in warp and weft, with a 2-and-2 twill backing weave. The weave marks are taken to indicate weft float. As the chief object should be the production of as perfect a face texture as is possible, the tying should be considered first in relation to the order in which the face warp and weft threads interweave with each other. The point-paper plan of the face weave enables the interweaving of the face threads to be seen at a glance, and thus affords a convenient means of reasoning out experimentally which is the better method, warp tying or weft tying, and also which is the best order of distributing the ties. Therefore, one or more repeats of the face weave are inserted lightly on the point-paper, as shown at A. In order to ascertain if warp tying can be employed, the positions of the backing ends are indicated between the face ends along the bottom of the plan, as shown at B, a face thread being arranged to precede a backing thread, in accordance with the order of warping. As the weave marks indicate weft float, two blanks alongside each other on the same face pick indicate that two consecutive face ends are raised at the same time, and therefore show a suitable position for raising a backing end between them over the pick. Thus on the first pick of the weave shown at B, the second and third squares are blank, therefore the second backing end may be raised over the first face pick. On the second face pick the seventh and eight squares are blank, therefore the seventh backing end may be raised over it, and so on. The positions of the warp ties may be conveniently indicated on the face weave by inserting marks where required between the blank squares, as shown at C. The selection of such a position for each tie ensures that one condition of warp tying will be fulfilled—viz., that where the backing warp enters the face cloth it will be covered on both sides by the adjacent face warp floats.

In order to ascertain if weft tying can be employed, the positions of the backing picks are indicated between the face picks at the side of the face plan, as shown at H in Fig. 49. In this case, two marks, one above the other, on the same end of the face weave indicate that a face end is passed over by two consecutive face picks, and therefore show a suitable position for passing a backing pick between them over the face end. Thus, on the first end of the weave H marks are inserted on the first, second, and third squares; therefore either the first or the second backing pick may be passed over the first face end, the former being preferable, as the tie will then be covered by two succeeding face picks. The positions of the ties may be conveniently indicated by inserting marks where required between the face weave marks, as shown at I. The selection of such positions ensures that where the backing weft enters the face cloth it will be covered on both sides by the adjacent face weft floats. After the positions of the ties have been indicated, the plan should be examined in order to ascertain if the best distribution has been obtained, the arrangement being modified if necessary.

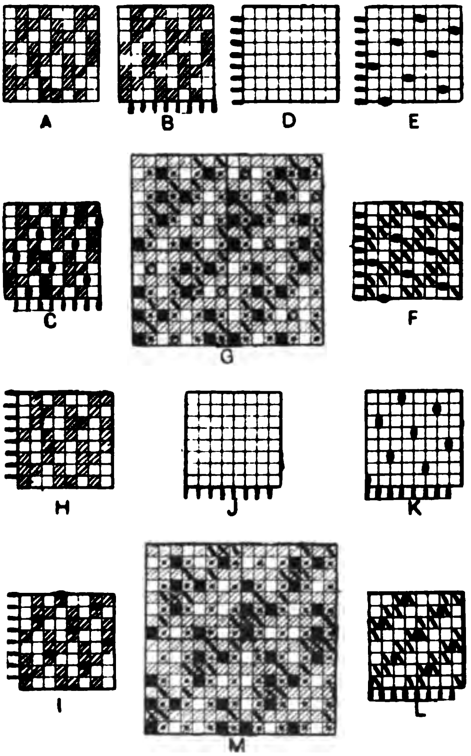


Fig. 49.

The next process is to find the best position of the backing weave in relation to the ties. A space is reserved for the backing weave, and taking warp tying first, the positions of the face picks are indicated between the backing picks at the side of the space, as shown at D in Fig. 49. (It is necessary to remember that a face thread precedes a backing thread, and that for each backing warp tie in the face fabric there is a face weft tie in the back fabric.) The positions of the ties are then copied from the face weave C on to the reserved space, as shown at E, the marks of the ties necessarily falling on the ends and between the picks of the backing plan. At C the tying marks indicate that backing ends pass over face picks, while at E they indicate that face picks pass under backing ends, which is the same thing. Thus

C and E show that on the first face pick the second backing end is raised; on the second face pick, the seventh backing end; on the third face pick, the fourth backing end, etc. With practice the ties are readily transferred from one plan to the other. In inserting the backing weave (the marks indicating weft), if possible, a square should be left blank above and below each tying mark, as shown at F. This ensures that each backing end will be raised on the backing picks which precede and succeed the tie; or, in other words, that each face weft tie on the underside of the cloth will occupy a position between two backing weft floats.

In the case of weft tying, the positions of the face ends are indicated between the backing ends along the bottom of the space reserved for the backing weave, as shown at J in Fig. 49. The positions of the ties are then copied from the face weave I, the marks being placed on the picks and between the ends of the backing plan, as shown at K. In I the tying marks indicate that backing picks pass over face ends, and, what is equivalent, in K they indicate that face ends are down on backing picks. Thus, the first backing pick passes over the first face end, the second backing pick over the sixth face end, and so on. In inserting the backing weave, if possible, a weave mark should be placed on both sides of each tying mark, as shown at L. This ensures that the backing ends on both sides of the tie are down—that is, each face warp tie on the underside of the cloth will occupy a position between two backing warp floats.

By thus carrying out the weaves, the double plan may afterwards be constructed from them in the most advantageous manner, or if the complete weave is not required, as is frequently the case in heald work, the draft and pegging plan may be constructed directly. G in Fig. 49 is the double weave from the face weave C and the backing weave F, the circles which indicate the warp ties corresponding in position with the tying marks in both weaves. M is constructed from the face weave I and backing weave L, the weft ties being indicated by the crosses, which correspond in position with the tying marks in the two weaves.

While the foregoing method may be employed with advantage for a simple arrangement, it is particularly useful in the construction of designs in which the backing weave is different from the face weave and in which, because of the irregular construction of the face weave, the ties require to be distributed in irregular order. The working out of an irregular type is illustrated in stages in Fig. 50, in which, it may be assumed, the face weave A is required to be backed with 2-and-2 hopsack weave in a 1 face, 1 back arrangement of the threads. In this instance the weave marks are taken to indicate warp, but the system of working is exactly the same as when weft is indicated if the marks in the face and back weaves are taken for blanks and *vice versa*. In order to ascertain if warp tying can be employed, the positions of the backing ends are indicated between the face ends, as shown at B in Fig. 50, then each pair of face ends between which a backing end is indicated is examined in turn. So far as regards the covering of the tie on the face of the cloth, in this case a suitable position is shown where marks are indicated on both ends of a pair. Thus in B the second and third squares are marked on the first and sixth face picks; therefore the second backing end may be raised on either of these picks. It is, however, not only necessary for a suitable position to be found in the face weave for each tie, but the distribution must also be considered—that is, there should, if possible, be the same number on each backing end and on each face pick, while the distribution should be as regular as possible. When, as is frequently the case with weaves of an irregular character, there are two or more positions in the face weave for tying some of the backing threads, and only one position for tying others, the latter should be dealt with first. Thus in weave B there is only one position available for each of the backing ends 1, 3, 5, and 7. Therefore, tying marks are first inserted at these places between the face ends, as shown at C. Then, as indicated at D, the remaining ties can be readily added to the plan with due regard to the order of distribution.

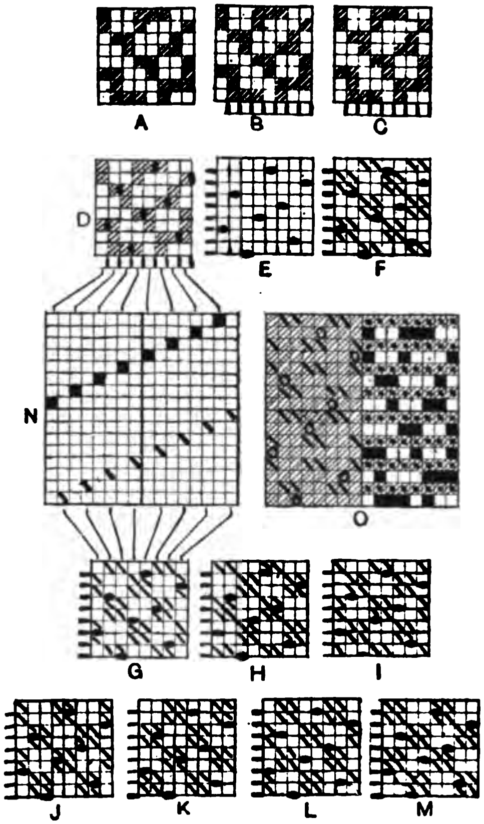


Fig. 50.

E in Fig. 50 represents the space reserved for the backing weave, the marks at the side of which show the order in which the face picks are inserted between the backing picks. The marks between the squares of E correspond with those indicated in D, and represent the positions where the face picks pass under the backing ends. The plans F to M show all the different positions in which it is possible to place the 2-and-2 hopsack backing weave in relation to the ties. As the weave marks indicate warp, the chief thing to avoid is the occurrence of a blank space above and below a tying mark, and it will be seen that all the plans, with the exception of G and J, are defective in this respect, as regards a proportion of the ties. In G and J the relation of the backing weave to the ties is not perfect, as it is impossible for the weave to be placed with a mark above and below every tying mark.

In the diagrams given in Fig. 51, in which the shaded lines represent the backing threads, the face weave D is shown backed with the 2-and-2 hopsack placed as indicated at G in Fig. 50. P is a flat view from the face side, while R shows the appearance of the underside when the cloth is turned over horizontally, as indicated by the numbers above the warp threads. The positions of the ties are shown by the solid marks, and it will be seen that they correspond with the marks between the squares ot D and G in Fig. 50. Q in Fig. 51 represents the interlacing of the threads 1 and 2, and S of the threads 3 and 4. The diagrams show how a face weft tie on the underside of the cloth corresponds with a backing warp tie on the face. The ties on threads 2, 6, 12, and 16 (which in G are indicated between two marks) are covered between two backing weft floats. Thus, in the section Q, the third face pick is shown entering the back fabric between the second and third backing picks. The ties on threads 4, 8, 10, and 14 (which in G have a mark on one side, and a blank on the other) have a backing warp float on one side and a backing weft float on the other. The position is clearly shown in section S, where the sixth face pick enters the back fabric between the fifth and sixth backing picks. The effect of placing the backing weave with a mark above and below a tying mark is shown by the dotted lines in Q and S. In Q the dotted line shows the interweaving of the backing end numbered 2, assuming that the backing weave has been placed as shown at H or I in Fig. 50, the float being broken by the tie on the third face pick. Similarly, the dotted line in S shows how the float of the backing end numbered 4 would have been broken by the sixth face pick if the backing weave had been placed at L or M.

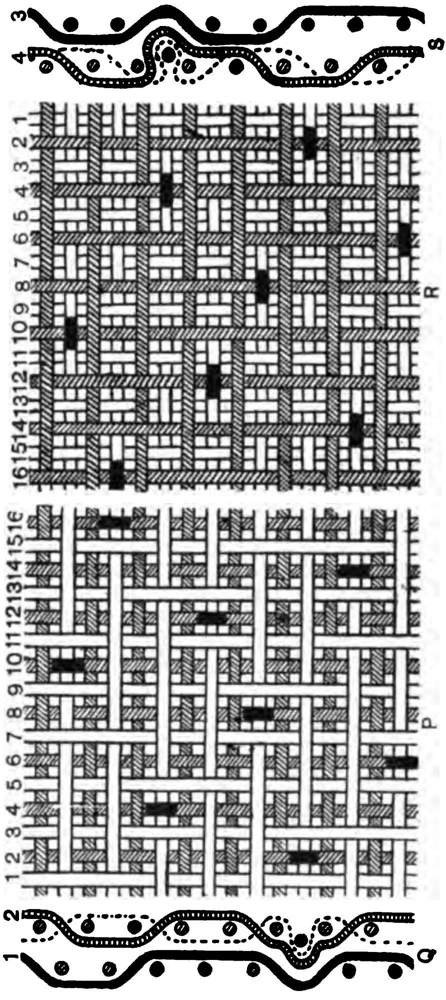


Fig. 51.

N and O in Fig. 50 respectively illustrate the construction of the draft and pegging plan directly from the face weave D, and the backing weave G. From an examination of D and G the number of healds that are required can be readily ascertained. Thus, D requires eight face healds because all the ends in the repeat work differently from each other, while G requires eight backing healds on account of the backing ends being raised for tying in 8-thread order. It is therefore only necessary to decide on the positions of the healds in order to construct the draft directly, as shown at N, in which the backing healds are placed in front of the face healds. The pegging plan O may then be constructed directly from D and G as follows:—(1) The positions of the backing healds and the backing picks are indicated lightly, as shown by the shaded squares. (2) The face weave is copied from D on to the face picks of the face healds, as shown by the full squares. (3) The backing weave is copied from G on to the backing picks of the backing healds, as shown by the diagonal marks. (4) The warp ties are copied on to the face picks of the backing healds from either D or G, as shown by the circles. (5) The face healds are marked up on the backing picks, as indicated by the dots. All the marks in O indicate healds raised.

In Fig. 52 the method of working is shown for a double-cloth in which the threads are arranged in the proportion of 2 face to 1 back in warp and weft, assuming that the face weave given at A is required to be backed with 2-and-2 twill. The weave marks are taken to indicate weft. An examination of A shows that weft tying is more suitable than warp tying so far as regards the covering of the ties on the surface of the cloth. Therefore the positions of the backing picks are indicated between the face picks in the order of 1 face, 1 back, 1 face, as shown at B. Each pair of face picks between which a backing pick is indicated is then examined in turn, and experiments are made until the best possible arrangement of the ties is obtained. This is shown by the marks between the picks of the plan C. D shows the positions of the face ends between the backing ends on the space reserved for the backing weave two face ends being indicated between each pair of backing ends. The method of transferring the ties from the face weave to the reserved space is similar to that already described in reference to the 1-and-1 arrangement of the threads, except that a tie on either (or both) of the face threads will be indicated between the same pair of backing threads. Thus the tying marks between the ends of the plan E correspond in position with those between the picks of C. Plans F, G, H, and I show the different positions in which the backing weave may be placed in relation to the ties. In this case while the best conditions are obtained when weave marks are placed on both sides of each tying mark, the chief thing to avoid is having a blank square on both sides. Plans F, G, and H are therefore defective, the only possible position of the backing weave being shown at I.

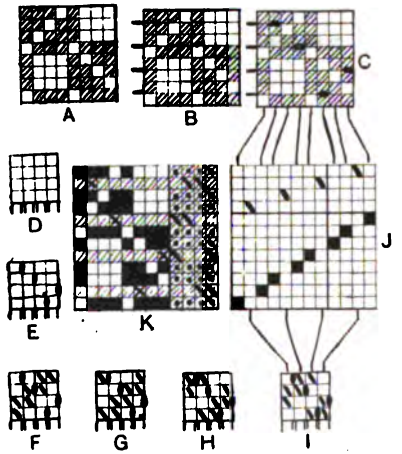


Fig. 52.

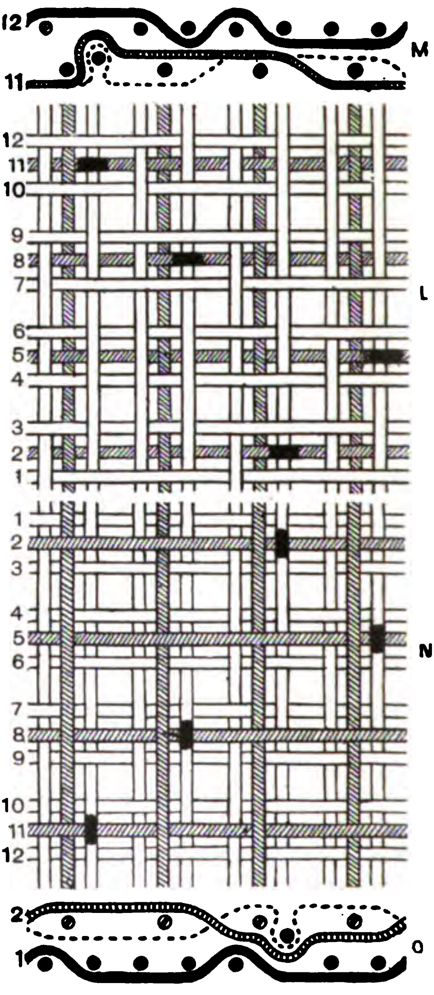


Fig. 53.

In the diagrams given in Fig. 53 the interlacings of the threads and the positions of the ties correspond with the weave marks and blanks, and the tying marks of plans C and I in Fig. 52. The structure, as viewed from the face side, is represented at L, and from the underside at N, assuming that the cloth is turned over from top to bottom, as indicated by the numbers alongside the weft picks. M shows the interweaving of picks 11 and 12 with their respective ends, and O of picks 1 and 2. From an examination of L it will be seen that each backing weft tie is perfectly covered on the surface of the cloth. N enables the relation of the ties to the backing weave to be observed; thus, a face warp tie on the underside corresponds with a backing weft tie on the surface. The ties on the picks 2 and 5 (which in I have a mark on both sides) are covered between two backing warp floats. This is also shown in section O, where the sixth face end enters the back fabric between the third and fourth backing ends. The ties on picks 8 and 11 (which in I have a mark on one side and a blank on the other) have a backing warp float on one side, and a backing weft float on the other, the position being also shown in section M, where the second face end enters the back fabric between the first and second backing ends. The dotted lines in M and O show the effect of placing the backing weave with a blank square on each side of a tying mark. In M the dotted line shows how the float of the backing pick 11 would have been broken by the tie on the second face end if the backing weave had been placed as at F in Fig. 52; while the dotted line in O shows how the float of backing pick 2 would have been similarly broken by the sixth face end if the weave had been placed as at G.

J and K in Fig. 52, respectively show how the draft and pegging plan may be constructed directly from the face and backing weaves, the backing healds, for the purpose of illustration, being placed behind the face healds. In this case, the backing weft ties are marked on the backing picks of the face healds, as shown by the crosses in K, while dots are inserted on the face picks of the backing healds, all the marks indicating healds down.

Reversible Double Weaves.—In no type is the correct placing of the backing weave in relation to the ties of greater importance than in the construction of reversible double weaves, such as are used for fine woollen and worsted overcoatings, in which the same effect is produced on both sides. Plans A to G in Fig. 54—in which weft is indicated—illustrate the construction of a reversible 7-shaft whipcord, in which the threads are arranged in the order of 1 face, 1 back, in warp and weft. As the back of the cloth is warp surface, the same as the face, the backing weave is exactly the opposite of the face weave. So far as regards the face of the cloth, the position of the backing warp ties may be varied, as shown in the plans A, B, and C, in each of which the tying places are indicated by the marks between the ends. The corresponding positions of the face weft ties are indicated by the marks between the picks of the plans D, E, and F respectively, in which it will be noted that the position of the backing weave is changed to accord with the position of the ties. Section H in Fig. 55 shows the interweaving of the first face and the first backing end with the weaves and ties placed as at A and D; section I, as at B and E; and section J, as at C and F. In each case the back of the cloth is as perfect as the face, the weaves being the same except that the twill runs in the reverse direction. G in Fig. 54 shows the complete double design with A as the face weave and D the backing weave.

Double-Cloths with Compound Face Weaves.—If warp tying be employed for a compound face weave, such as that shown at K in Fig. 54, an important principle to note is, if possible, to distribute the ties in the same order throughout the complete repeat. This is particularly necessary when a simple backing weave is employed. For example, assuming that the threads are arranged 1 face, 1 back, in warp and weft the best order of distribution for the twilled hopsack in the first section of K is the 8-sateen order. The same order may be employed for the 2-and-2 twill section, therefore the 8-sateen distribution may be used regularly throughout the repeat, as shown by the marks between the ends of K. Then if a simple backing weave, such as the 2-and-2 twill shown at L, be employed, the backing ends may be drafted in straight order on to eight healds. If, however, the ties for the twilled hopsack section are placed as shown by the marks between the ends of M, it is necessary for a break to be made in the order of distribution where the weave changes. An irregularity of this kind may not only complicate the drafting of the backing ends, but in this case for a 2-and-2 twill backing weave, 16 backing healds are required, because as shown at N, the ties are in a different position relative to the backing weave in the two sections of the design.

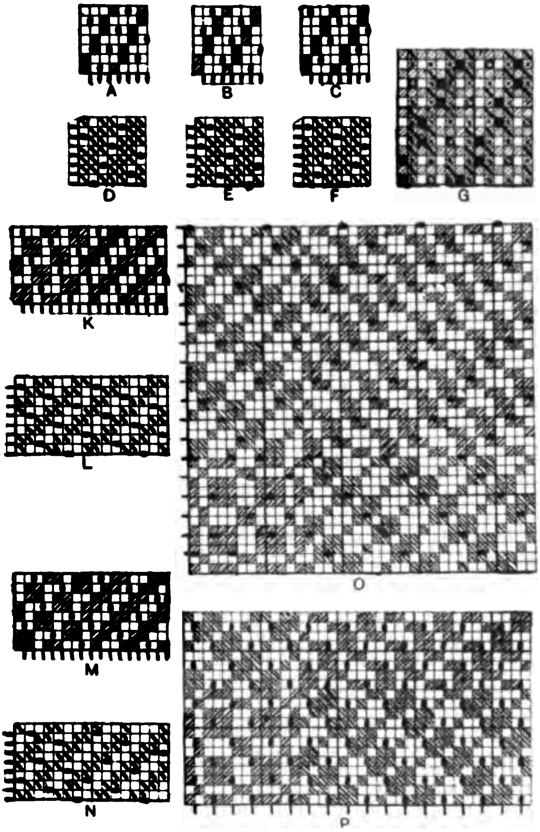


Fig. 54

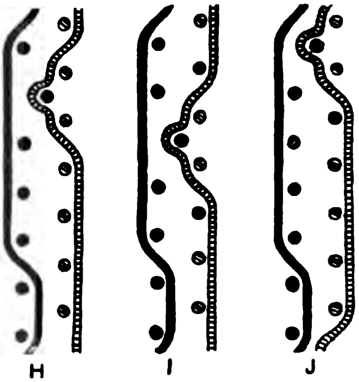


Fig. 55.

In the production of compound face weaves which require a large number of healds, tying with the backing weft gives more scope for variety of effect in dobby weaving than tying with the backing warp. For example, in a 2-and-1 arrangement of the threads, the ends of the face weave given at O in Fig. 54 may be depressed for tying in the order indicated by the marks between the picks, and 20 face healds are required, while if a plain backing weave be used, only two backing healds are necessary. The weave marks of O indicate weft. On the other hand, stitching with the backing warp would necessitate the use of a large number of backing healds if the ties were as effectively concealed as in weft tying. In some cases, however, the cheaper classes of piece-dyed cloths, in which compound face weaves are employed, are tied by means of the backing ends, which are raised for tying in regular order. Thus, if the weave given at O in Fig. 54 is backed with plain weave, and the ties distributed in plain order, only two backing healds are necessary, the same as in weft tying. The backing healds, in this system, are raised alternately for tying, as shown by the marks between the ends of P, irrespective of the face weave, except that care is taken to so plan the weave that the defective ties are reduced to the lowest possible number. In a piece-dyed cloth the defects on the face are not so apparent as when there is a difference in colour between the face and backing yarns.

CHAPTER III

SPECIAL CLASSES OF DOUBLE CLOTHS

Double Cloths in which the Threads Interchange. Cut Double Cloths—Cut Effects produced by Interchanging the Threads—Designs in which the Cut is produced by interweaving the Threads in 3-and-3 order. *Double Plain Cloths*—Styles arranged 1-and-1 as to Colour—Correct Joining of Double Plain Weaves—Double Plain Horizontal Hairline—Intermingled Double Plain Effects—Specially arranged Double Plain Stripes—Double Plain Spotting—Broad Double Plain Stripes—Double Plain Cloths Specially Coloured in the Warp—Comparison with the First System—Cutting and Joining the Weaves—Methods of Colouring the Backing Ends—Method of Designing Stripe Patterns—Construction of Double Plain Check Patterns—Double Plain Effects in Three or Four Colours—Four-Shade Effects Coloured 1-and-1 in the Warp—Three-Colour Patterns arranged 1 Face, 1 Back in the Warp—Four-Colour Patterns arranged 1 Face, 1 Back in the Warp. *Double Twill and Sateen Stripe Designs.*

DOUBLE CLOTHS IN WHICH THE THREADS INTERCHANGE

THE method of interchanging the threads, illustrated by the plans A and B in Fig. 56, and the drawings in Fig. 57, is employed for reversible cloths in which very loose weaves are required on the face and back. The odd ends and picks, which in the example form the 10-thread hopsack pattern A on both sides of the cloth, are alternately above and below a plain fabric formed by the even ends and picks. A weft float formed on the surface by the odd picks has a corresponding warp float on the underside formed by the odd ends, and *vice versa;* each odd end and pick thus floating loosely on one side or the other without interweaving with the other threads, except where the interchange is made. The necessary firmness of structure is secured by the plain weaving of the even threads which form a centre fabric, and by the interchanging of the loosely woven threads through it. In the complete plan given at B in Fig. 56, the positions of the threads which are in the centre are indicated by the shaded lines. After the plain weave of the centre threads has been inserted over the repeat, as indicated by the diagonal marks, it is only necessary to insert marks on the odd ends and picks (as shown by the full squares) in the sections where the weft is required on the surface. (The marks in Fig. 56 represent weft.) The odd picks thus float over all the ends, and the odd ends are down on all the picks; while in the remaining sections, where the warp is required on the surface the odd picks pass under all the ends, and the odd ends are raised on all the picks. This is clearly shown in the flat view of the structure given in the upper portion of Fig. 57. The section on the right of the flat view shows the interweaving of the ends 1 and 2, and that below of the picks 1 and 2. The diagrams indicate the method in which the ends and picks respectively change from one side to the other of the plain centre fabric. The threads which form the centre fabric require to be much finer than those which float on the face and back.

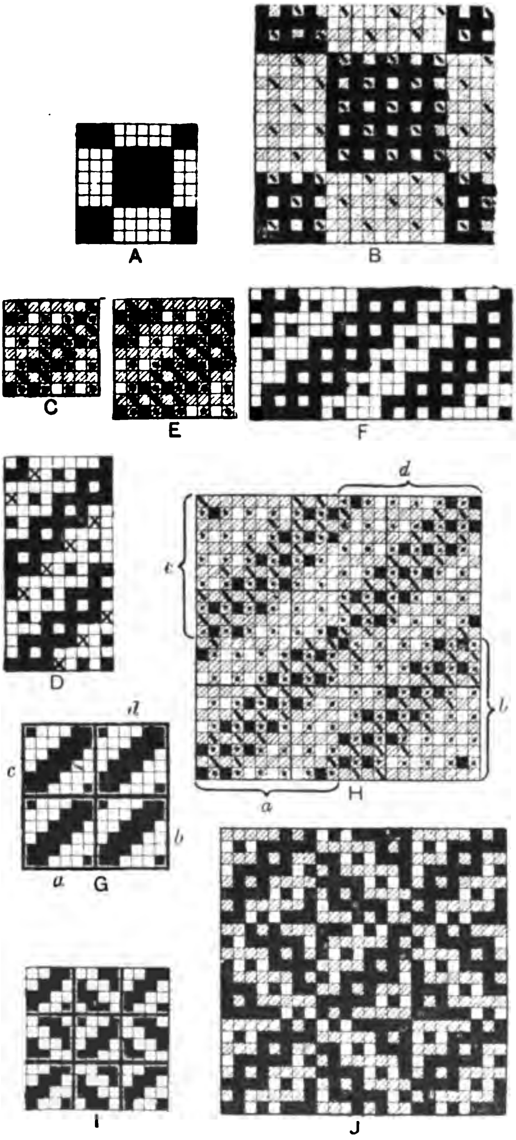


Fig 56.

All ordinary double weaves constructed for 1-and-1 warping and wefting may be readily re-arranged to interchange on the principle illustrated by the plans C, D, E, and F in Fig. 56. In this system one series of threads, either warp or weft, enters about equally into the face and back fabrics, passing alternately from face to back, and from back to face. Usually it is better to interchange the warp threads, as the cloth can then be woven from one warp beam. Also, a lower quality of weft can be used for the under than for the face fabric, while fewer healds are required than when the interchange is in the weft threads.

C in Fig. 56 shows an ordinary double 2-and-2 twill weave from which the ties are omitted; the threads are arranged 1 face, 1 back in warp and weft, and the repeat occupies eight ends and picks. For the warp interchange the repeat is made either one end less, or, as shown at D, one end more than the number of ends in the repeat of the original weave C, and the weave C is inserted in the manner illustrated by the full squares in D. Because the weave C is a 1-and-1 arrangement while the repeat of D contains an odd number of ends, it is necessary for two repeats of the twill to be run in before the repeat for the picks is complete. This causes the odd ends to enter the face fabric and the even ends the back fabric in one twill, while in the other twill the positions of the ends are reversed. The picks, however, are always retained in their respective positions, the odd picks being on the face and the even picks on the back throughout ; hence the backing weft may be different from the face weft, as in the ordinary type of double cloth. The additional float, indicated by the cross on each face pick of D, may be in either weft or warp, although in this case weft is preferable, as the face twill is thus made more definite. An effect similar in appearance to a double 2-and-2 twill is obtained, but the weave is really between a 2-and-2 and a 3-and-2 twill.

The flat view, to correspond with the design D (in which the marks represent weft), is given in Fig. 58, the shaded lines indicating where the threads are on the underside. The section on the right of the flat view shows the interweaving of the first two ends, and enables the method in which the ends change from one fabric to the other to be readily seen. The interchange is so frequent that a firm, solid structure results without the ordinary system of tying being employed.

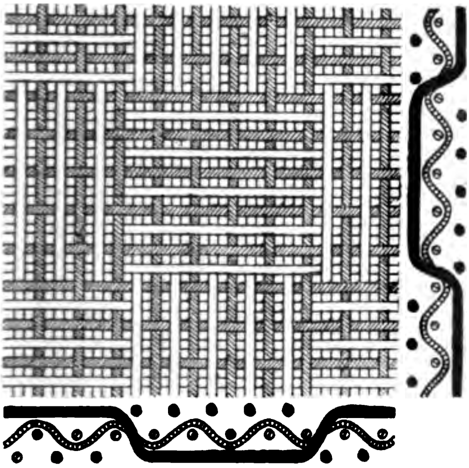


Fig. 57.

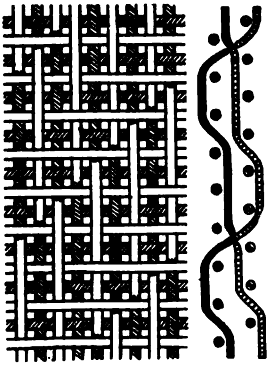


Fig. 58.

E in Fig. 56 shows an ordinary double 3-and-2 twill with the ties omitted ; while F shows the weave arranged to interchange in the weft. In this case the repeat for the picks is made an odd number by increasing it by one, the two lines of the twill thus occupying 22 ends. The odd ends are always on the face, and the even ends on the back, which renders it possible for a lower quality of warp to be used for the back than for the face. The effect which is obtained is between a 3-and-2 and a 3-and-3 twill. If the repeat had been made on 9 picks and 18 ends the weave would have produced an effect between a 3-and-2 and a 2-and-2 twill.

CUT DOUBLE CLOTHS

In these a division of the face weave is obtained by means of fine lines which may run in the direction of the warp, of the weft, or of both warp and weft. If the lines are near together, tying on the ordinary principle is not necessary, as the cuts serve to unite the two fabrics. When, however, there is a rather large space between the cuts, say more than one-fifth of an inch, extra tying places are required in order to produce a firm structure. The cut or line effect can be produced in either of the following methods :—(1) By interchanging the threads. (2) By interweaving the face and back threads together in 3-and-3 order.

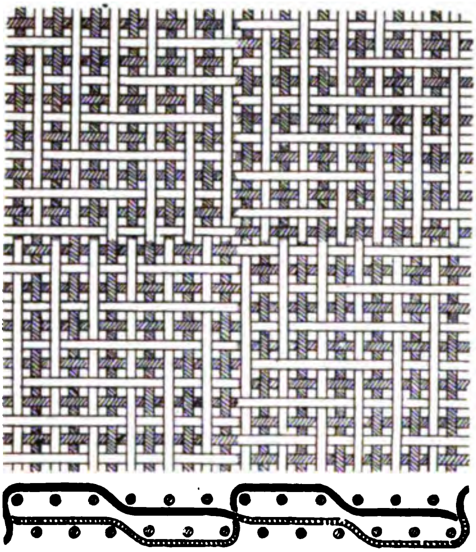


Fig. 59.

Cut Effects produced by Interchanging the Threads.—This system is employed in well-set-up cloths in which the threads are arranged in the proportion of 1 face to 1 back in warp and weft, neat designs resulting from reversing the ends and picks in sections, according to the form of pattern required. For example, G in Fig. 56 shows the positions of the lines for the production of a cut check of equal spaces on the face and back in a double 3-and-3 twill, while the shaded squares in the complete double weave given at H indicate the positions of the backing threads in the various sections. The cuts between *a* and *b*, and between *c* and *d*, are obtained by reversing the picks ; and between *a* and *c*, and *b* and *d*, by reversing the ends. Thus, although every portion of the cloth is double in structure, each end and pick forms part of both the face and the back fabric, and a perfectly regular structure can be obtained with only one warp beam. In H the face weave is indicated by the full squares, and the backing weave by the diagonal marks, the dots showing where the backing ends are down on the face picks.

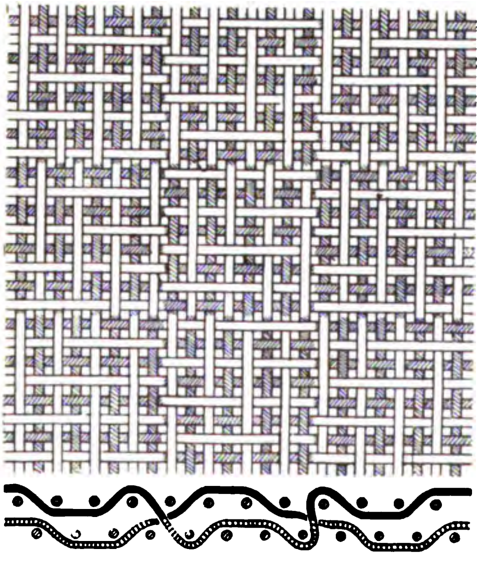


Fig. 60.

The flat view, to correspond with the design H in Fig. 56, is given in the upper portion of Fig 59, and a section showing the interweaving of picks 3 and 4 in the lower portion. As the threads pass alternately from face to back and from back to face, it will be clear that additional variety of effect may be obtained by arranging the threads as to colour in different orders. For example, with a 1-dark, 1-light order of warping and wefting, a solid dark surface would be formed in section *a* of the design H, where the odd ends interweave with the odd picks. In section *b*, where the odd ends interweave with the even picks, an intermingled colour effect would be produced on the surface, while a similar effect would be formed in section *c*, where the even ends interweave with the odd picks. In section *d* the interweaving of the even ends with the even picks would form a solid light surface. The colour effect on the underside would be exactly the reverse of the face in the solid portions.

Although with the weave H a line is produced on both sides of the cloth by the interchanging of the threads, the 3-and-3 twill is really continuous throughout in both fabrics. A better defined and deeper cut is obtained if the face and backing weaves are arranged on the principle shown at I in Fig. 56. In this case the face weave also cuts along the line where the threads interchange, and the direction of the twill is reversed in alternate sections. The arrangement causes a similar cut to be formed in the double weave given at J, in which only one kind of weave mark is shown, in order that it may be more clearly seen how the weft opposes the warp where the interchange takes place. This is also shown in the corresponding flat view given in the upper portion of Fig. 60, and in the section showing the interweaving of picks 1 and 2 in the lower portion. From an examination it will be seen that a thread which floats on the surface of the upper fabric interchanges directly to the underside of the lower fabric, and *vice versa*. This is not the case with all the threads when the weave is arranged as indicated in Fig. 59. The reversing of the twill, as shown in Fig. 60, assists in bringing out the cutting line sharp and clear.

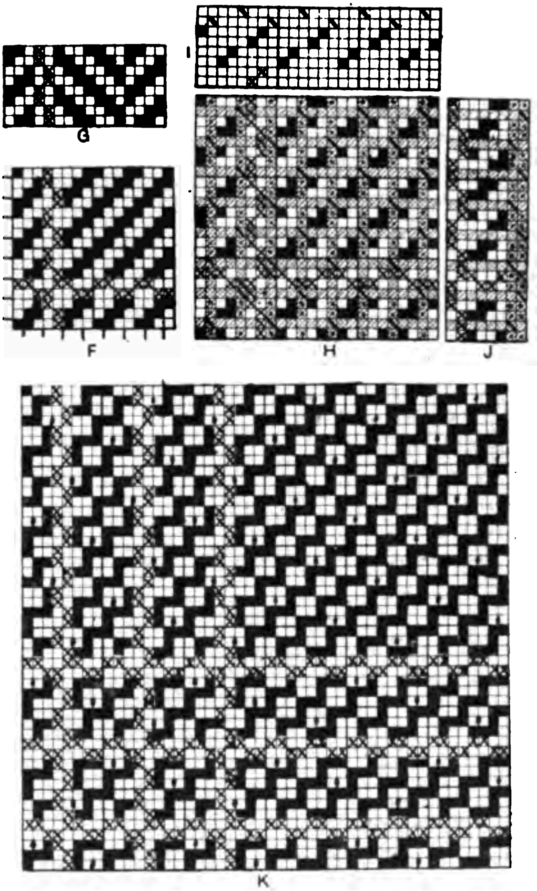


Fig. 61.

Designs in which the Cut is produced by interweaving the Threads in 3-and-3 order.—This is the more common method of producing the cut or sunk effect, and it is usually employed in cloths in which the threads are arranged in the proportion of 2 face to 1 back in warp and weft. In this system both the face and the backing threads assist in forming the line, and it is necessary for the weaves to be arranged in precise order in relation to the threads to obtain the best results. In the first place at each cut two face threads between a pair of backing threads are arranged to weave in 2-and-2 order with the face picks, and to oppose each other with their floats, as shown by the crosses on the fourth and fifth ends and picks ot the face plan given at F in Fig. 61. Also each face float of 2 is arranged to include a face end or pick on each side of a backing end or pick. The face weave is then placed, as far as possible, to support the cutting threads. Thus in F the float of one cutting thread is a continuation of the twill, while that of the other increases the float of the face weave. If the face weave is placed so as to oppose the cutting threads, as shown at G in Fig. 61, which illustrates a defective plan, the line is made more open and not so distinct.

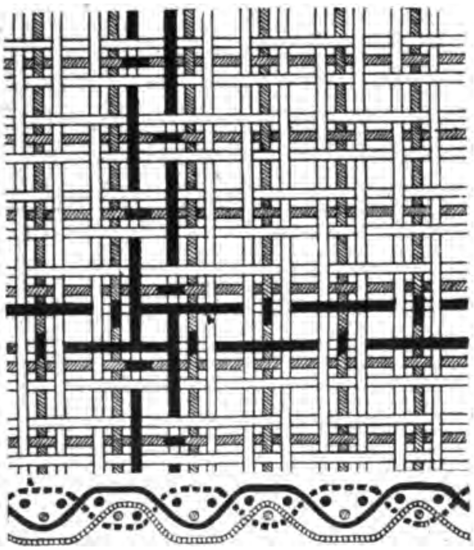


Fig. 62.

In constructing the complete design, which is given at H in Fig. 61, the backing thread between each face float of two is given a corresponding float, the cutting threads thus interweaving in 3-and-3 order, as shown by the crosses on the sixth and seventh ends and picks of H. Each 3-float passes under, or over, 1 face thread, 1 backing thread, and 1 face thread. The plain backing weave also requires to be placed to support the cutting threads, as shown by the diagonal marks which are inserted against the crosses. In some cases, in order to increase the sunk effect, the cutting ends are woven as tightly as possible from a separate beam. Under ordinary circumstances, however, these ends weave tighter than the rest, and it is usual to draw them through the healds near the front in order that, in shedding, they will be subjected to the least possible strain. The draft for H, on the lowest possible number of healds, is given at I, and the pegging plan at J, in which the marks indicate healds down.

The flat view given in the upper portion of Fig. 62 shows the interweaving of the ends and picks 1 to 18 of the weave H in Fig. 61, the threads which assist in forming the cut being indicated in solid black. The solid line in the section given in the lower portion of Fig. 62 shows the interweaving of the first face cutting pick, the dotted line of the second, and the shaded line of the backing pick which precedes them. The method of interweaving not only forms the sunk effect between the face cutting threads, but the face and back fabrics are tied very firmly together along the cuts.

In constructing elaborate designs, the positions and the order of interweaving of the cutting threads may, with advantage, be first indicated on the space occupied by the face weave, as shown by the crosses in K, Fig. 62. The face weave—in this case the twilled hopsack—may then be arranged in the best position for supporting the cutting threads, and if the space between the lines is so great that extra stitching is necessary, the positions of the additional ties can be indicated, as shown in K, in which the marks between the blank squares represent backing warp ties. The complete double-cloth design is readily constructed from a face plan arranged as shown at K.

DOUBLE PLAIN CLOTHS

Double plain weaves which are tied by means of the backing warp, as shown at A and B in Fig. 63, are employed for solid coloured dress-face cloths, which require to be very firm in structure. In the design A the threads are arranged 1 face, 1 back in warp and weft, and in B in the proportion of 2 face to 1 back; the marks indicate weft. In double-plain weaving, however, the object is usually to produce cloths in which patterns are obtained which are due (*a*) to the combination of differently arranged double-plain weaves, and (*b*) to the method of arranging the threads as to colour.

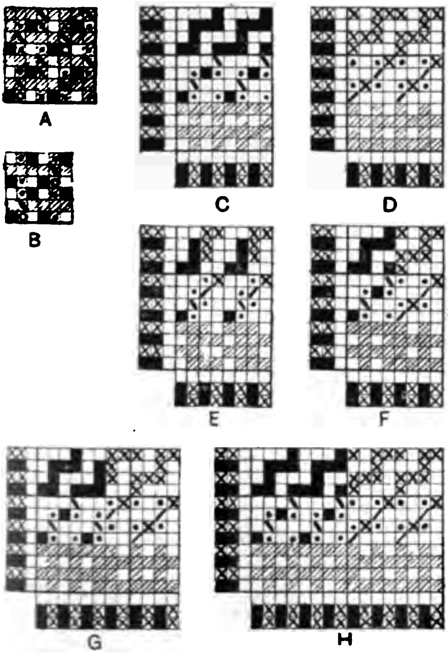


Fig. 63.

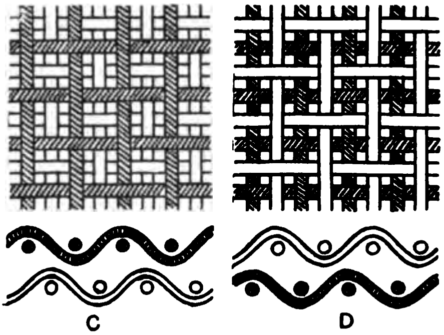


Fig 64.

Two opposite double-plain weaves are given at C and D in Fig. 63. With the weave C (taking the marks to indicate weft) the odd ends and picks form the upper, and the even ends and picks the lower plain fabric. This is illustrated by the corresponding flat view, and the section which shows the interweaving of the first and second picks, given at C in Fig. 64. With the weave D in Fig. 63 the threads are in the reverse positions, the upper fabric being formed by the even ends and picks, and the lower fabric by the odd ends and picks, as represented at D in Fig. 64. In each case the two plain fabrics are quite separate from each other, but by combining the weaves C and D the threads are caused to interchange, and a firm compact structure is formed, so long as neither weave extends for more than about eight threads.

There are two principles upon which the threads may be arranged as to colour, viz. :—(*a*) In the order throughout of 1-and-1 in warp and weft; (*b*) in regular order in the weft, but with the warp colour order varied according to the form of pattern which is required. The first arrangement is used in the production of spotted vestings and figured fabrics, and in stripe patterns for suitings and trouserings. The second method is chiefly limited to the production of stripe effects, for which, however, it has certain advantages over the first method. In the following both systems of constructing double-plain stripe patterns, for suitings, trouserings, and costume fabrics, are described and illustrated.

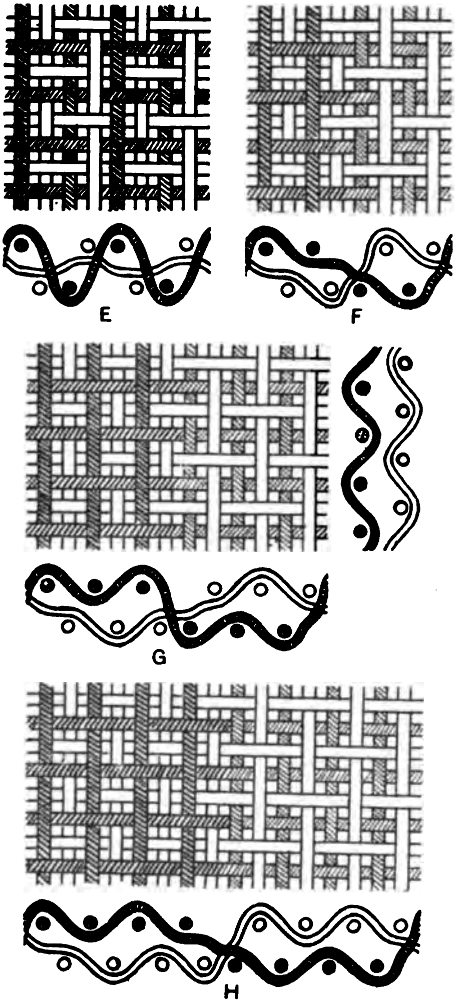


Fig. 65.

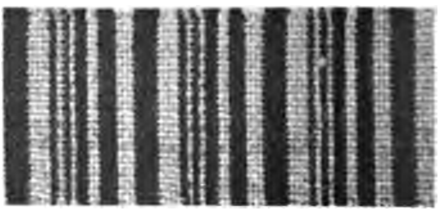


Fig 66.

Styles arranged 1-and-1 as to Colour.—In this method, with the threads arranged 1 dark, 1 light in warp and weft, the weave C (Fig. 63) produces a dark over a light surface, and the weave D a light over a dark surface, as shown by the drawings given at C and D respectively in Fig. 64, in which the dark threads are represented by the shaded lines. By combining the weaves in sections, therefore, any form of pattern in two colours may be obtained. This is illustrated by the plans E, F, G, and H in Fig. 63, and by the corresponding drawings, similarly lettered, given in Fig. 65. In E the ends 1 and 2 of C are combined with the ends 3 and 4 of D, a single-thread hairline stripe lengthwise of the cloth being formed. In F, 4 ends of C are combined with 4 ends of D, a stripe pattern in 2 dark, 2 light colouring being obtained. In G, 6 ends of C are combined with 6 ends of D, and in H 8 ends of C with 8 ends of D, the former producing a stripe effect in 3 dark, 3 light, and the latter in 4 dark 4 light colouring on the surface. The effect produced by combining the plans E, F, G, and H, Fig. 63, in stripe form is shown in Fig. 66, the colour pattern on the surface of the cloth being 1 dark, 1 light, 1 dark, 1 light, 2 dark, 2 light, 3 dark, 3 light, 4 dark, 4 light.

In order to produce a pattern in which each section is in solid colour, it is necessary for the warp and weft colours to be alike, and for each colour of weft to interweave only with its own colour of warp. An examination will show that this is the case in the examples E, F, G, and H in Figs. 63 and 65; and further, that the colour pattern on the underside of the cloth is in each exactly the reverse of that on the face.

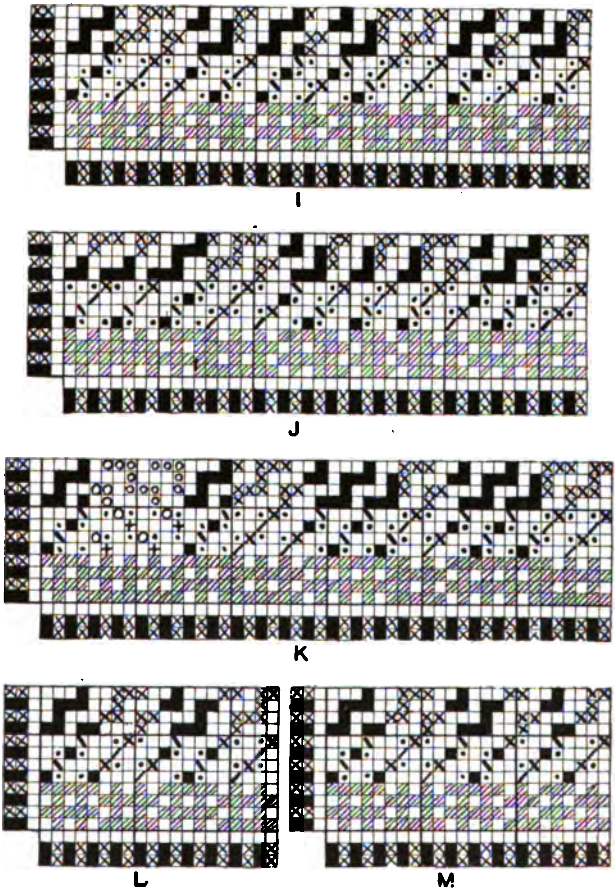
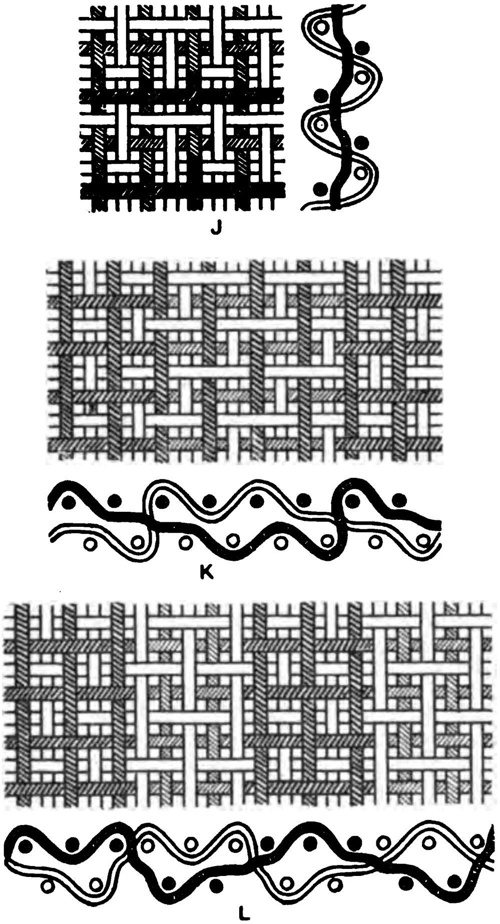


Fig. 67.

In the flat views the odd ends and picks are shaded to represent the dark threads; but in order to show a distinction where these threads are on the underside, the shading is somewhat lighter than where they are on the surface. The section below each flat view shows the interweaving of the picks 1 and 2. The picks pass alternately from face to back and from back to face, a firm structure thus being formed. The section on the right of the flat view, given at G, shows the inter- weaving of the ends 1 and 2. No interchange takes place in the warp threads in stripe patterns of this character, each end being retained on the face or back continuously.

In order that the method of construction may be conveniently analysed, the plans C to H in Fig. 63, and also the designs in Fig. 67, are each shown in three portions. In the bottom portion the shaded squares indicate the backing ends and picks, hence the blank squares show where the face ends intersect the face picks. In the centre portion the weaves are shown in different marks; thus for the face weave the full squares indicate where the dark face picks pass over the dark face ends, and the crosses where the light face picks pass over the light face ends; for the backing weave, the diagonal marks inclined to the left show where the light backing picks pass over the light backing ends, and the diagonal marks inclined to the right where the dark backing picks pass over the dark backing ends; while the dots denote the backing ends down on the face picks. In the top portion, the full squares indicate the sections where the odd or dark threads are on the surface, and the crosses the even or light threads. The arrangement of the threads as to colour is indicated along the bottom and at the side of each plan, the solid marks denoting the dark ends and picks, and the crosses the light ends and picks. The patterns represented in Fig. 69 correspond with the designs that are similarly lettered in Fig. 67.


J

K

L

Fig. 68.

Correct Joining of Double Plain Weaves.—In combining the weaves it is necessary for care to be taken that not more than a float of three is made in a design where the interchange is made. In the 1-and-1 order of colouring the threads, a correct junction is assured if the face and backing weaves are placed in the same relation to each other in every section of the pattern. For example, if the centre four picks of I, Fig. 67, be examined, it will be seen that the full squares and crosses which are used for the face weave are always in the same relation to the diagonal marks which are used for the backing weave, a continuous line in 1-and-3 twill being formed. The pattern produced on the surface of the cloth by design I is 2 dark, 3 light, 2 dark, 1 light, 2 dark, 1 light, as shown at I in Fig. 69. Designs in which each section requires to be in solid colour may therefore be readily constructed by first dividing the repeat into sections according to the desired pattern, and inserting the 1-and-3 twill over the given surface. Marks are then added above and below the twill marks on those ends which are required on the underside. (If marking for warp is practised, marks are added above and below the 3-and-1 twill marks on the ends which are required on the surface.) As the face colour pattern of I repeats on an odd number of ends (11) it has been necessary to extend the design over two repeats (22 face and 22 backing ends).

Again as each weave C and D in Fig. 63 repeats on four threads, a correct junction is obtained if one weave commences with the thread which is next in number to the thread with which the other weave finished. Thus, in the design I the first section finishes with the fourth end of C, while the second section commences with the first of D. The second section finishes with the second end of D, which is followed by the third of C, and so on.

Double Plain Horizontal Hairline.—If the picks 1 and 2 of C, Fig. 63, are combined with the picks 3 and 4 of D, a hairline effect across the piece is formed. The horizontal hairline, however, is seldom used except in small spaces in combination with other effects in the manner shown at J in Fig. 69. The pattern on the surface of this example is 4 horizontal hairline, 2 dark, 3 light, 2 dark, 1 light, 1 dark, 1 light, 1 dark, 2 light, 3 dark, 2 light. In the complete design given at J in Fig. 67, the horizontal effect is produced by the weave shown on the first 8 ends. The corresponding flat view of this portion of the design, and a section showing the interweaving of the ends 1 and 2, are given at J in Fig. 68, in which it will be noted that the horizontal hairline is produced by the interchanging of the ends.

Intermingled Double Plain Effects.—In the pattern shown at K in Fig. 69, variety of effect is obtained by the introduction of a stripe in which the colours are intermingled. The effect on the surface of the cloth is 2 dark, 4 mixed, 2 dark, 3 light, 4 dark, 2 light, 4 dark, 3 light. The design is given at K in Fig. 67, the mixed effect being produced by the section shown in circles in the top portion. An examination of the centre four picks of K, in which the circles indicate where the face weft passes over the face warp, shows that in the mixed effect the light picks interweave with the dark ends on the surface of the cloth. This is more convenient in this case because, as shown in the bottom portion of K, the ends may be arranged 1 face, 1 back in continuation of the order in which they are arranged for the two dark stripes

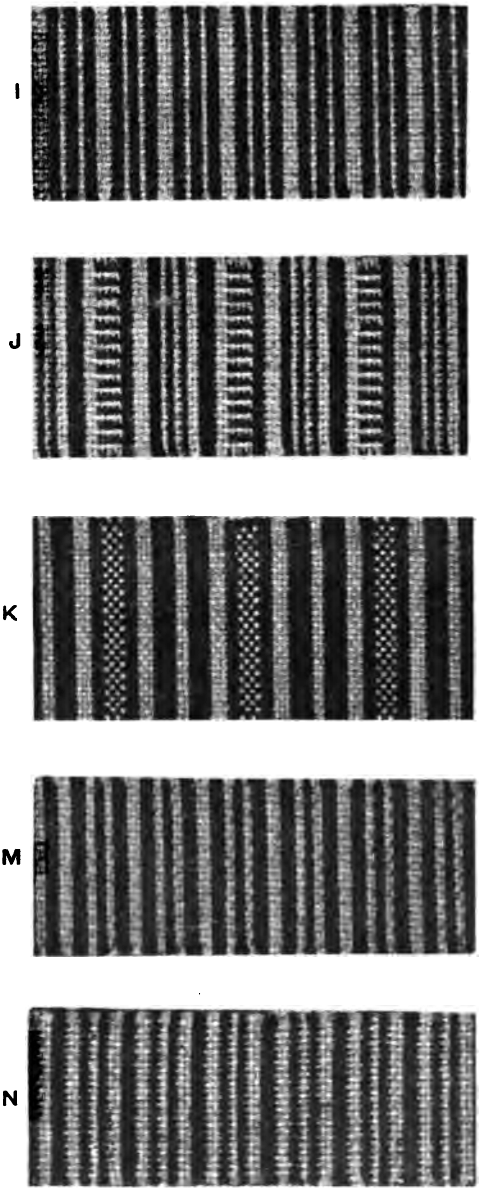
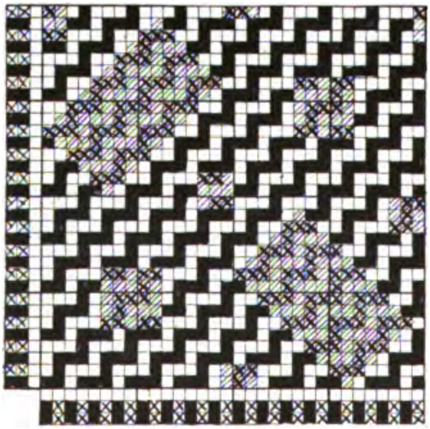


Fig. 69.

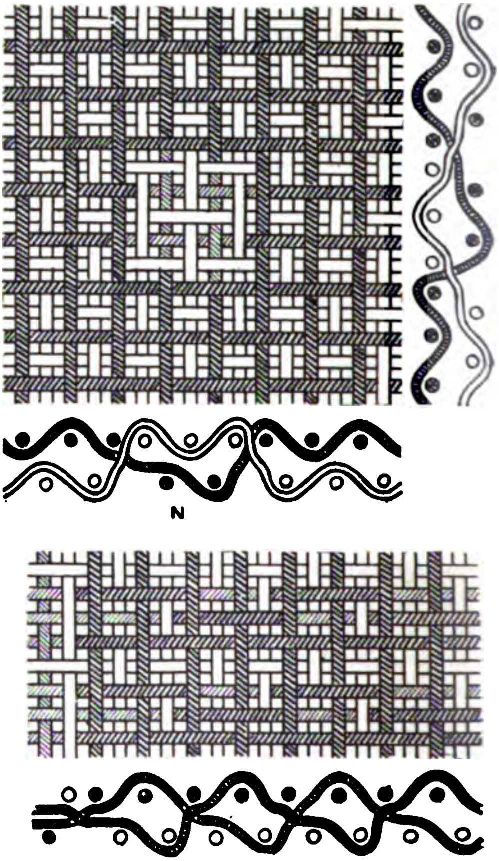
between which the mixed effect is placed. This makes it possible, by reversing the weave as shown, to place it to cut with the weave on each side, a better defined stripe thus being formed.

The method in which the ends 1 to 16 of the design K in Fig. 67 interweave is illustrated by the flat view given at K in Fig. 68, and the section showing the interlacing of the first and second picks. On the underside of the cloth a similar intermingled effect is produced by the dark weft interweaving with the light warp, which is a suitable arrangement when the mixed effect is introduced between two light stripes.



N

Fig. 70.



N

O

Fig. 71.

Specially arranged Double Plain Stripes. — In the foregoing stripe designs it will be noted that 2 face or 2 backing ends are brought together where the change from one colour to the other is made. It is sometimes feasible, however, with the same order of colouring, to avoid having 2 backing ends together by arranging the weaves on the principle shown at L in Fig. 67. In this case, as shown in the bottom portion of the plan, each section contains an odd number of ends, so arranged that the two ends which are brought together where the interchange is effected are face ends. This, necessarily, causes more ends to be brought to the face than to the back, although the picks are equal on both sides. The flat view of the design L, and a section showing the interweaving of the picks 1 and 2, are given at L in Fig. 68. There are 3 face ends to 2 backing ends, the pattern formed on the surface of the cloth being 3 dark, 3 light, and on the back 2 light, 2 dark. In this principle of construction each section contains one backing end less than the number of face ends. Thus, for a pattern in 2 dark, 2 light on the face, there will be 2 face ends to 1 backing end, and the effect on the underside will be 1 light, 1 dark; while for a 4 dark, 4 light face pattern there will be 4 face ends to 3 backing ends, and the effect on the back will be 3 light, 3 dark. More elaborate stripes may be contructed on the same principle. For example, M in Fig. 67 shows the design for the pattern represented at M in Fig. 69, the effect on the face being 3 dark, 3 light, 3 dark, 2 light, 2 dark, 2 light. In the repeat of the design there are 15 face ends to 9 backing ends. N in Fig. 69 shows the appearance of the cloth on the underside, the pattern being 1 dark, 1 light, 1 dark, 2 light, 2 dark, 2 light. It is necessary for care to be taken that the same number of face ends is sleyed through each split of the reed.

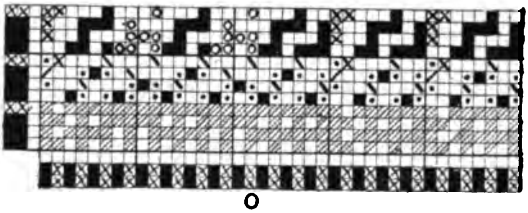

O

Fig. 72.

Double Plain Spotting.—In the construction of stripe patterns the interchange is usually in the weft only, the warp threads being retained on the face or back continuously. The exception is when a section of the horizontal hairline is introduced. In spotted patterns, such as are employed in vesting styles, however, the interchange is in both warp and weft. An example is given at N in Fig. 70, in which the shaded portions indicate where light spots are brought up on a dark ground. In constructing the design the weave D, Fig. 63, is inserted in the spotted sections, and the weave C in the ground. The flat view showing the interweaving of the ends and picks 1 to 16 of the design N in Fig. 70 is given at N in Fig. 71. The sections below and alongside the flat view, which respectively show the interweaving of the picks 6 and 7, and the ends 6 and 7, illustrate the method in which both the warp and weft threads change from one side to the other.

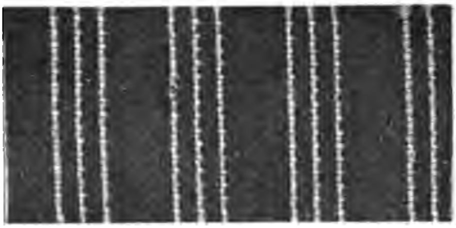


Fig. 73.

Broad Double Plain Stripes.—A broad, solid-coloured, double-plain stripe can be produced in the 1-and-1 order of warp colouring, by changing the weft colour plan to 3-and-1, and by arranging the weaves on the principle illustrated at O in Fig. 72. The limitation of the arrangement is that only one thread of one of the colours can be brought to the surface at a place. In this case the wefting is 3 dark, 1 light, and the pattern formed on the face of the cloth is 1 light, 11 dark, 1 light, 3 dark, 1 light, 3 dark, as shown in Fig. 73. The flat view of the ends 1 to 18 of Fig. 72 and a section showing the interweaving of the picks 2 and 3 are given at O in Fig. 71. An examination and comparison with the design will show that the light pick is always on the underside, and the first dark pick always on the surface, except where the single thread lines in light colour are formed. In the broad stripe the second and third dark picks alternately pass from one side to the other every four ends, effectively binding the stripe and preventing the cockling of the cloth, which would otherwise have resulted on account of the fabrics being separated for too wide a space.

Double Plain Cloths specially Coloured in the Warp.—This, the second method of producing double plain stripe patterns, is illustrated by the designs given in Fig. 74, and the diagrams shown in Figs. 75, 76, and 77. As in the former examples, the plans are shown in three portions, with the order of colouring indicated along the bottom and at the side; while in the drawings, the shaded lines represent the dark threads, the shading being lighter where they are on the underside. In this method the ends are arranged 1-and-1 throughout as to their positions on the face and back, and the picks usually 1-and-1 as to colour, but a change is made in the order of colouring the ends at each change of the pattern.

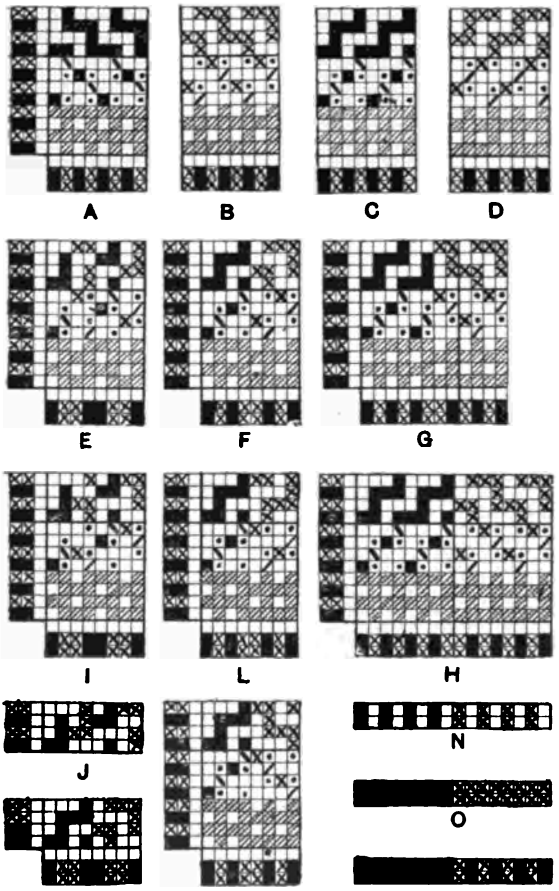


Fig. 74.

In the two opposite double-plain weaves given at C and D in Fig. 74, the ends are arranged 1 face, 1 back, and the picks 1 dark, 1 light. With the ends also arranged 1 dark, 1 light, the weave C produces a dark over a light surface, as shown at C in Fig. 75. The ends of the weave D are arranged 1 light, 1 dark. On the surface the odd (light) ends interweave with the even (light) picks, and on the underside the even (dark) ends with the odd (dark) picks. Thus a light-coloured over a dark fabric is formed, as shown at D in Fig. 75. In the plans A and B in Fig. 74 the twill lines formed by the weave marks run in the opposite direction, but they produce exactly the same effects as to colour as the plans C and D, as will be seen by comparing the corresponding drawings A and B with the drawings C and D in Fig. 75. The weave A or C may therefore be combined with either the weave B or D, so that more latitude in joining the weaves is found in this than in the first system.

Comparison with the First System.—In order that this system of construction may be readily compared with the previous system, the designs and orders of colouring are given at E, F, G, and H in Fig. 74, which will respectively produce in the second system the same colour patterns as the plans E, F, G, and H in Fig. 63 (p. 69). The combination in stripe form of the designs E, F, G, and H, Fig. 74, will therefore also produce the pattern shown in Fig. 66. The flat views given in Fig. 76 respectively correspond with the designs similarly lettered in Fig. 74, while the section below each flat view shows the interweaving of the picks 1 and 2. As the drawings given in Fig. 65 correspond in the same manner with the designs E, F, G, and H in Fig. 63, the two Figs. 65 and 76 also afford a means of comparing the two systems. It will be noted that in both cases the order of wefting—viz., 1 dark, 1 light—and the positions of the backing picks are the same. The difference is in the arrangement, first of the ends, and second of the weaves; the latter necessarily requiring to conform with the arrangement of the ends. In the first system the order of warping is 1 dark, 1 light throughout, and 2 face or 2 backing ends are brought together where a change in the pattern is made. In the second system, on the other hand, the order in the warp is 1 face, 1 back throughout, and 2 dark or 2 light ends are brought together at each change of the pattern. Thus, in producing a pattern in 4 dark, 4 light colouring on both sides of the cloth, in the first system the ends in the order of 1 dark, 1 light are arranged 1 face, 1 back for 4 times, and 1 back, 1 face for 4 times, as shown at H in Figs. 63 and 65; while in the second system the ends in the order of 1 face, 1 back are arranged 1 dark, 1 light for 4 times, and 1 light, 1 dark for 4 times, as shown at H in Figs. 74 and 76.

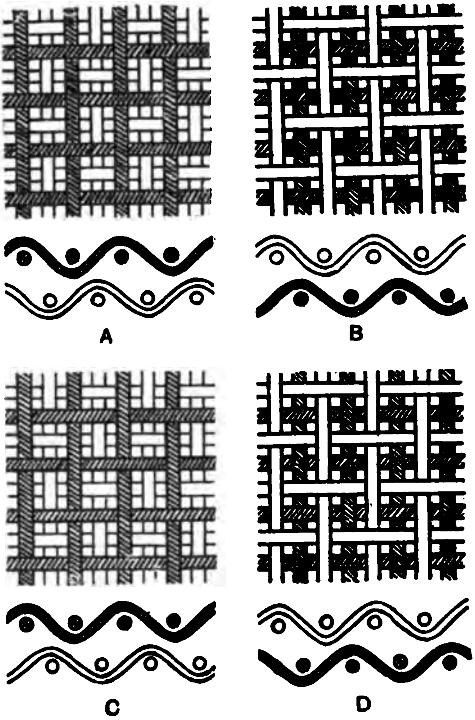


Fig. 75.

The advantages of the second system of constructing stripe patterns are:—(1) A more even cloth results, because the bringing of 2 face or 2 backing ends together is avoided. (2) The production of more than a float of three where the weaves join is impossible if each pick, when on the surface, interweaves only with its own colour of warp. (3) If necessary the weaves can be arranged to cut where the interchange takes place. For worsted cloths this is a better method than joining the weaves, so long as the cutting does not occur too frequently, as the pattern is thus brought out smart and definite. Cutting in small sections and several times in succession, however, should usually be avoided, as it is liable to produce a ribbed cloth and to cause hardness of handle, this being particularly the case in woollen cloths.

Cutting and Joining the Weaves.—In E, F, G, and H, Fig. 74, the weaves are arranged to cut at each change of the pattern, as is distinctly shown in the top portions of the designs. In each case, however, the weaves may be arranged without the cutting, or to cut at one change and not at another. Thus the design I shows

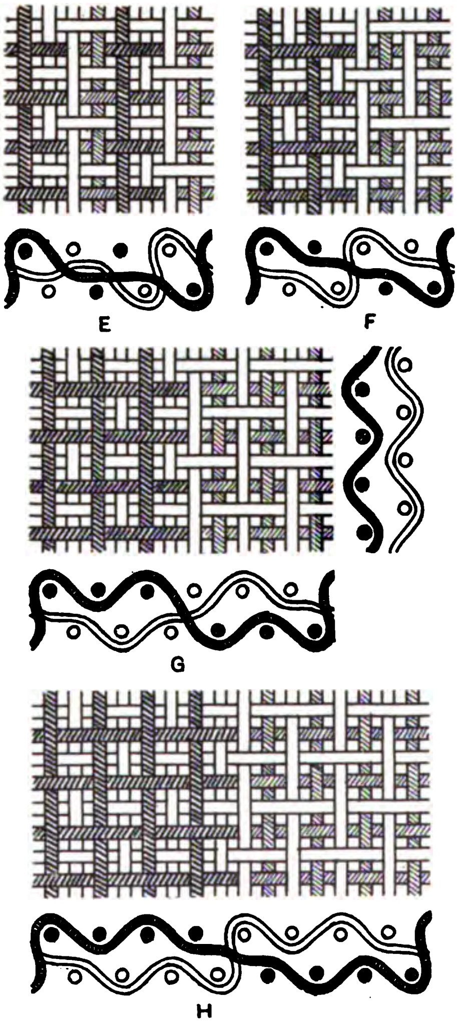


Fig. 76.

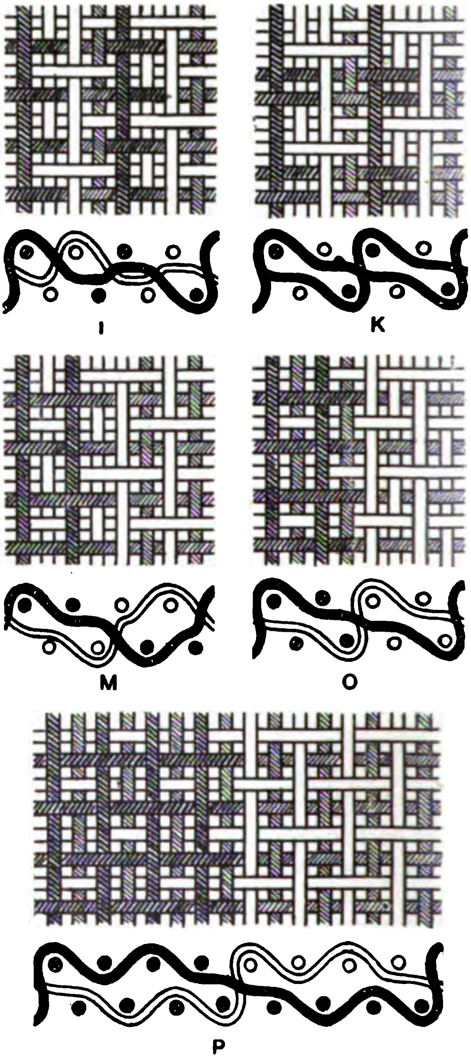


Fig. 77.

how the vertical hairline may be obtained with the weaves cutting every 4 ends, instead of every 2, as in the design E; while J shows how the same effect may be formed without the weaves cutting. The flat view given at I in Fig. 77 corresponds with the design I, while the section below shows the interweaving of the picks 1 and 2. The most common method of producing the single-thread vertical hairline, with the weaves cutting every four ends, is illustrated by the design K in Fig. 74, and the drawings shown at K in Fig. 77. In this case, while the arrangement of the warp colouring is the same as that for the designs E, I, and J, the threads interlace in the same order as in the design F. The wefting, however, is changed to 2 dark, 2 light, hence the pattern may be produced in looms with changing boxes at one end only. Design L in Fig. 74 shows how the two-thread stripe pattern may be formed with the weaves cutting every 8 ends, and M without the weaves cutting, the colour effect in each case being the same as that produced by the design F. The flat view and the section showing the interweaving of the picks 1 and 2, given at M in Fig. 77, correspond with the design M in Fig. 74.

Methods of Colouring the Backing Ends.—If the plans E to M in Fig. 74 are carefully analysed and compared with the corresponding drawings, it will be seen that each colour of weft interweaves only with its own colour of warp, and solid lines of colour are formed on both sides of the cloth. It will also be seen that with the warp colours arranged on the principle indicated below the designs E to M, the pattern on the underside of the cloth is exactly the reverse of that on the face, which in many cases is a distinct advantage. If, however, the colour pattern on the underside is of little or no importance, the backing ends may be in either dark or light, or practically any colour, since these ends remain on the back all the time, while the face ends are continuously on the face, as shown in the section alongside the flat view given at G in Fig. 76. In such a case, therefore, so long as the face ends are arranged as to colour in accordance with the form of the pattern which is required on the surface, the order of warping may be materially simplified by colouring the backing warp in sections to conform with the face order of colouring. For example, the design given at H in Fig. 74 will produce the pattern 4 dark, 4 light on the surface, if the face ends are arranged in the order of 4 dark, 4 light, as shown at N. So far as regards the face of the cloth, the complete warping plan may therefore be 8 dark, 8 light, as shown at O, which is a simpler arrangement than the warping order which is necessary in order that the face and back will be alike. In the same manner the warping plan for the 2-dark, 2-light stripe produced by the design F may be 4 dark, 4 light, and for the 3-dark, 3-light stripe produced by the design G, 6 dark, 6 light. Again, assuming that the dark shade of warp is cheaper than the light shade, the warping plan for the design H may be as indicated at P, the more expensive yarn thus being used economically. The backing warp may also be in a different colour from either of the face warp colours, and it may be different in thickness. The weft, however, should be in the same colours as the face warp, and similar in thickness, and it is usually an advantage to insert more picks than ends per inch, as greater solidity of colouring is thereby obtained. The flat view of the design F, with the warp colours arranged 4 dark, 4 light, is given at O in Fig. 77, while the section shows the interweaving of the picks 1 and 2. In the same manner the drawings given at P in Fig. 77, correspond with the design H in Fig. 74, the warp colours being arranged in the order shown at P. If the drawings given at F and H in Fig. 76 are compared with O and P in Fig. 77, it will be noted that on the face the patterns are respectively the same, the change in the warping plan simply affecting the underside, where an intermingled colour effect is produced.

Method of Designing Stripe Patterns.—The method of constructing a stripe design is illustrated at Q, R, S, T, U, and V in Fig. 78. It is assumed that the ends are arranged 1 face, 1 back, the picks 1 dark, 1 light, and that the pattern to be formed on the surface of the cloth is 3 dark, 2 light, 3 dark, 1 light, 2 dark, 1 light. The position of the backing ends, the order of wefting at the side, and the face warping plan below the ends, are first indicated, as shown at Q. The complete order of colouring the ends may afterwards be arranged, as described with reference to the weave H,

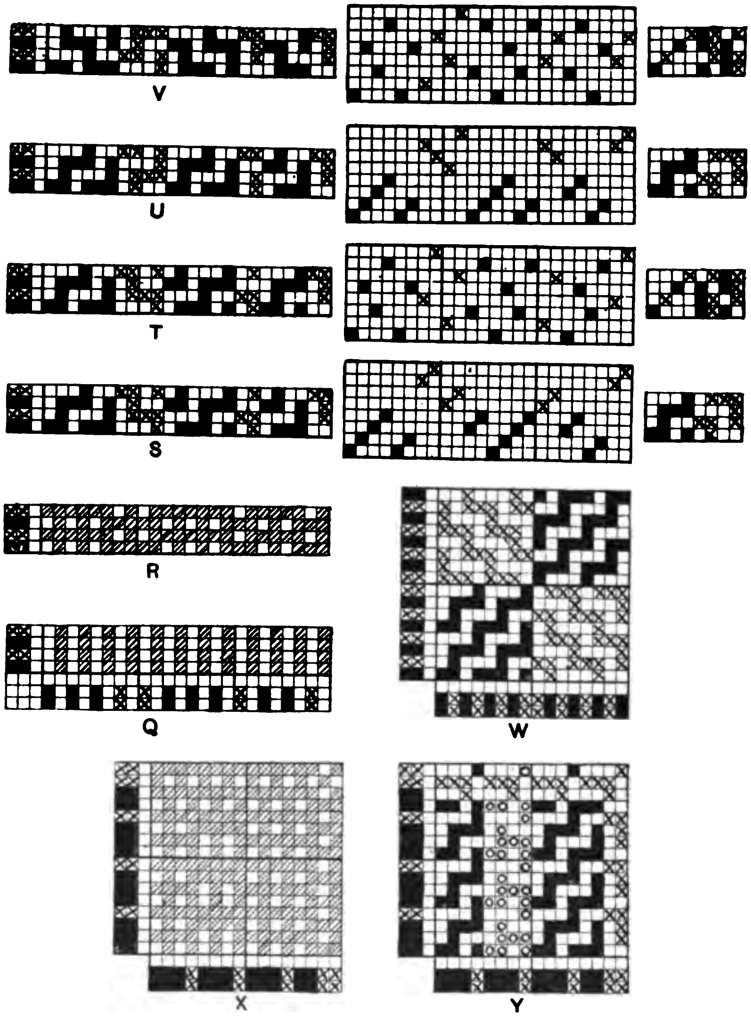


Fig. 78.

Fig. 74, according to the effect which is required on the underside. R shows the positions of the backing picks which are indicated—in the dark sections on the light picks, and in the light sections on the dark picks. The blank squares show where the face ends and face picks intersect, and it will be noted that a dark end intersects a dark pick, and a light end a light pick. Each colour of weft is thus arranged to interweave on the face only with its own colour of warp; and, if the weave A or C, Fig. 74, is inserted on the dark sections, and the weave B or D on the light, the required colour pattern will be formed on the surface of the cloth, although, as experiment will show, the weaves may be combined in many different ways. S shows the weaves arranged to cut at each change of the pattern, while in T a cut is made only at each side of the 3's of dark colour. U shows another arrangement with the weaves cutting at each change, and V with the cutting as at T. Other combinations may be made which will produce the same colour pattern on the surface, but one of the chief objects to note in arranging the weaves is the simplification of the drafting.

The respective drafts are given alongside the designs S, T, U, and V, and the weaving or pegging plans on the right of the drafts, the marks indicating healds down. Two sets, of four healds each, are required in each case, but while in the drafts for S and U the front four healds produce the dark sections of the pattern, and the back four healds the light sections, the drafts for T and V are arranged with the face threads drawn on the front four healds, and the backing threads on the back four healds. The draft for S is the simplest arrangement, because not only are the mails per unit space of the healds in each set the same, but the order in which the threads are drawn in can be readily followed. The order of drafting is 1, 2, 3, 4, throughout, a change from one set of healds to the other being made at each change of colour. In the draft for the design T a definite system is also employed for the simplification of the drawing-in. Thus, the dark face ends are on the odd healds, and the light face ends on the even healds of the front set. The first heald of the front set is followed by the first heald of the back set, the second by the second, and so on. Further, in the case of tappet shedding, the design and the draft may, with care, be made to conform with any given weaving plan. For example, if the threads 19 to 22 of the draft for the design S are drafted 1, 2, 3, 4, instead of 3, 4, 1, 2, the lifting plan for S will produce the design T. The design U may be taken to illustrate a defective combination of the weaves to fit a given weaving plan. In this case with the lifting plan the same as for S the draft is unsatisfactory, because not only is it difficult to follow, but there is an extreme variation in the setts of the healds.

Construction of Double Plain Check Patterns.—The method of arranging the colours and the weaves for producing a *check* pattern in sections of 4 dark, 4 light colouring on both sides of the cloth is illustrated by the design W in Fig. 78. The order of colouring in the weft is the same as that in the warp—viz., 1 dark, 1 light for 4 times, and 1 light, 1 dark for 4 times. The pattern is obtained by the interchanging of both the warp and the weft threads.

Examples X and Y in Fig. 78 illustrate the construction of a large check pattern in which the effect is due to lines formed in a single thread of one of the colours. The order of colouring in both warp and weft is 3 dark, 1 light for as many times as required, and 2 dark, 2 light. In X the positions of the backing ends and picks are indicated by the shaded lines, and in Y the different weaves by different marks. Any size of check may be obtained by repeating the ends and picks 1 to 8; while the repetition of the ends and picks 9 to 16 will enable variety of effect to be formed by the introduction of two or more of the single lines of colour. The binding of the large section of solid colour is effected by two out of each four picks passing alternately from one side to the other in the manner illustrated by the example given at O in Figs. 71 and 72.

Double-Plain Effects in Three and Four Colours.—As there are only four picks in the repeat of the double-plain weave, the limit as to the number of colours which can be introduced is four, if each line on the surface is required to be solid in colour. If one colour is brought to the surface for two or more consecutive threads, in order to form a plain weave there must be at least two picks of that colour out of the four in the repeat of the wefting plan. Hence, in such a case, the limit as to the number of colours is three, of which two must form single lines of colour.

In the designs given in Figs. 79 and 83 the weave marks indicate weft, and the differently coloured threads are represented by different marks along the bottom and at the side of each plan. In the bottom portion the shaded squares show the position of the threads when on the underside. In the centre portion the marks which indicate where the weft passes over the face ends correspond with the marks which are used to represent the colours; the diagonal marks indicate the backing weave, and the dots the backing ends down on the face picks. In the top portion a different kind of mark (corresponding with that used to represent the colour) is employed for the purpose of indicating the surface colour of each section of the pattern.

Flat views and sections showing the interweaving of the threads are given of the majority of the designs; and in order that comparisons between them may be readily made, the threads in the diagrams are shaded in different ways to represent the colours. The colours are also indicated by numbers—shade 1 corresponding with the full squares on the point paper, shade 2 with the circles, shade 3 with the crosses, and shade 4 with the vertical lines.

Four Shade Effects Coloured 1-*and*-1 *in the Warp.*—The designs A and B in Fig. 79, and the corresponding drawings, similarly lettered, in Fig. 80, will serve to illustrate the method of producing patterns in four colours in the system of arrangement in which two face or two backing threads are brought together where the weaves interchange. The shades in the warp are arranged in the order of 1, 2, 3, and 4 throughout, and in A the wefting is in the same order. The weave in section 1 of A brings the odd ends and picks in shades 1 and 3 to the surface, while the even ends and picks in shades 2 and 4 pass to the underside. Each face end floats under its own colour of weft and over the other colours, vertical lines in shades 1 and 3 being formed on the face. The weave in section 2 of A brings the even ends and picks in shades 2 and 4 to the surface, while the odd ends and picks in shades 1 and 3 pass to the underside. Again each face end floats under its own colour of weft and over the other colours, with the result that vertical lines in shades 2 and 4 are formed on the face. The complete pattern produced on the surface by the design A is a single thread stripe with the shades arranged in the order of 1, 3, 1, 3, 2, 4, 2, 4. By combining four threads of section 1 with four threads of section 2, the single thread vertical hairline in four colours is formed.

The design B in Fig. 79 is exactly the same as the design A, except that in the weft the shades 2 and 4 are reversed in order that they will occupy different positions in relation to the corresponding shades in the warp. An examination and comparison with the drawings given at B in Fig. 80 will show that in section 3 each face pick passes under its own colour of warp and over the other colours, with the result that horizontal lines in shades 2 and 4 are formed on the surface. In the same manner, if the shades 1 and 3 are reversed, section 1 will produce horizontal lines. The complete effect produced on the surface by the design B is a stripe arranged—one of shade 1, one of shade 3, one of shade 1, one of shade 3, and four of the horizontal hairline in shades 2 and 4.

With regard to the underside of the cloth, an examination will show that in A, section 1 produces a horizontal hairline in shades 2 and 4, and section 2 a similar effect in shades 1 and 3; while in B, section 1 produces a vertical hairline in shades 2 and 4, and section 3 a horizontal hairline in shades 1 and 3.

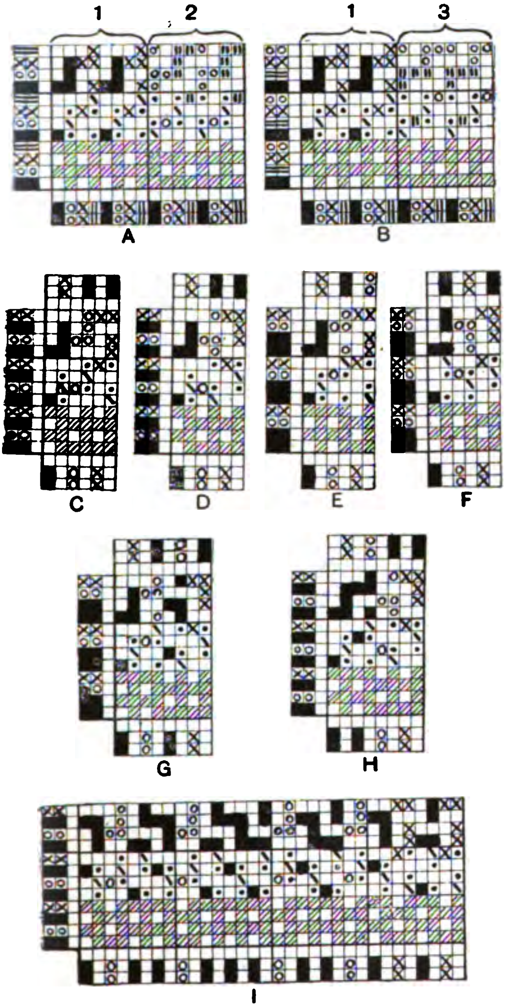


Fig. 79.

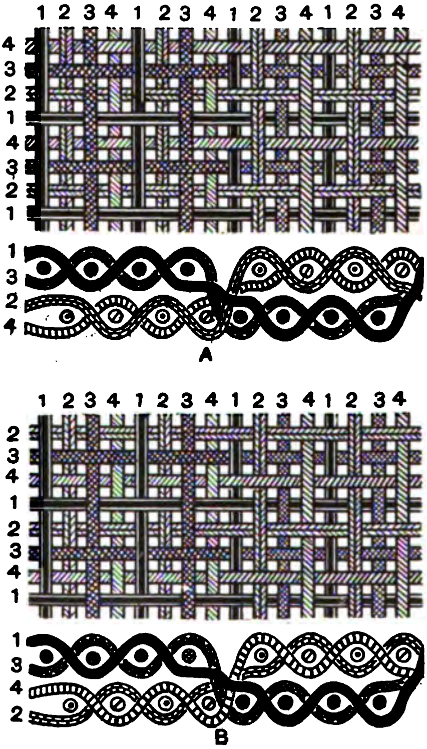


Fig. 80.

It is evident from the foregoing that with the warp arranged 1-and-1 throughout in four shades there is considerable scope for producing variety of pattern in stripe form by varying the spaces occupied by the weaves and by changing the order of wefting. The weaves may also be arranged and combined to form figured styles in which the pattern is due not only to contrast in colour, but the direction of the lines of colour may be varied as desired. Three-colour effects may be obtained by employing the same shade for all the odd or for all the even threads.

Stripe patterns in three and four colours are usually produced in the system in which the ends are arranged 1 face, 1 back throughout. In the warping plan the chief point to note is that the face ends are coloured according to the form of stripe which is required on the surface, and in the following examples the colouring of these ends only is indicated below the designs.

Three-colour Patterns arranged 1 *Face,* 1 *Back in the Warp.*—Examples C, D, E, and F in Fig. 79 show different ways of constructing a vertical hairline in three colours. It will be noted that the arrangement of the face warp colours is the same in each case, but in C and D the shades in the weft are in the order of 1, 2, 1, 3, and in E and F in the order of 1, 1, 2, 3. In C and E the weaves do not cut; in D one cut, and in F two cuts are made. The flat views of the weaves C and F representing two repeats in each direction, and sections showing the interweaving of the picks, are given at C and F respectively in Fig. 81. In the drawings the backing ends are not shaded, because, so far as regards the face of the cloth, they may be in any colour. Thus, the complete warping plan may be two of shade 1, two of shade 2, and two of shade 3, etc. If, however, solid lines of colour are required on the underside, it is necessary for each backing end to be in the same colour as the pick over which it is raised. For example, in the design C, the first backing end is raised on the pick in shade 3, and the second and third on the picks in shade 1. If, therefore, the backing ends are coloured to correspond, when the cloth is turned over the shades on the underside will be in the order of 1, 1, 3. The arrangement of the backing

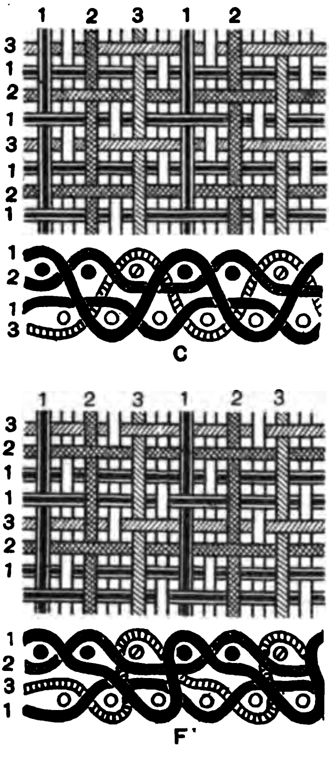


Fig. 81.

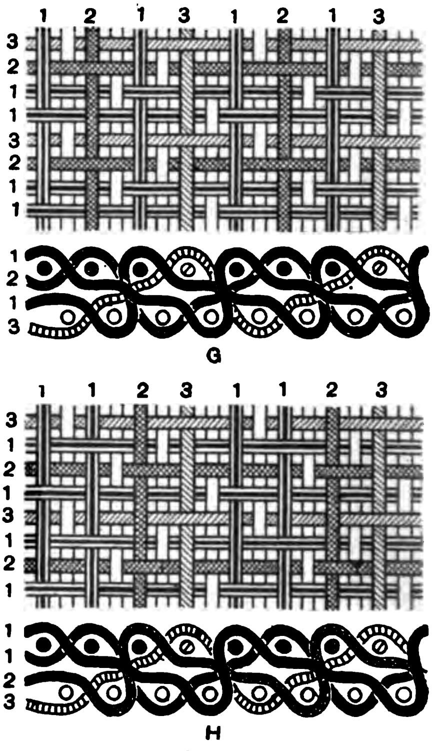


Fig. 82.

ends as to colour, which will produce solid lines on the underside, is indicated above each plan. It will be noted that the pattern is not the same as that on the face, except in the design E, for which the shades in the complete warping plan will be in the order of 1, 3, 2, 1, 3, 2.

Two standard three-colour hairline arrangements are given at G and H in Fig. 79, and the corresponding drawings at G and H in Fig. 82. In the pattern produced by G the shades on the surface are in the order of 1, 2, 1, 3, and by H in the order of 1, 1, 2, 3, as indicated by the numbers above the warp threads in the flat views. The complete warping plan for G may be two of shade 1, two of shade 2, two of shade 1, and two of shade 3; and for H, four of shade 1, two of shade 2, and two of shade 3; but if the backing ends are coloured in the order indicated above the designs, the pattern on the underside will in each be exactly the same as that on the face.

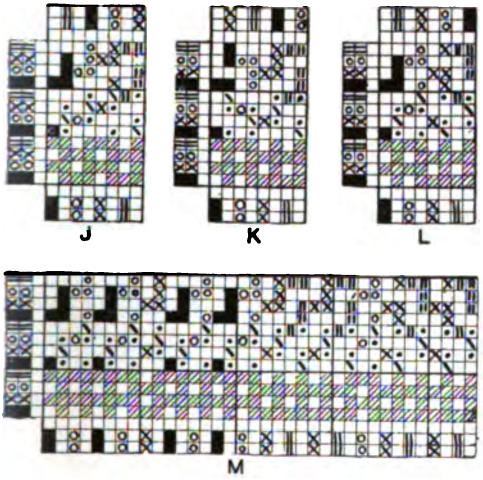


Fig. 83.

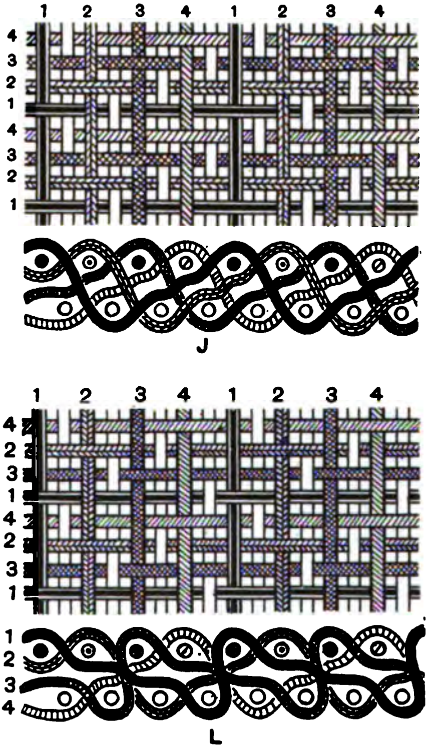


Fig 84.

So long as two of the colours are used only to form single-thread stripings, a great variety of stripe effects can be produced by varying the spaces occupied by the third or ground colour. An example is given at I in Fig. 79, which will produce the following pattern on the surface :—

Shade 1—	1	2	3	2	1	1
Shade 2—	1	1	1	1	.	.
Shade 3—	.	.	.	.	1	1

Four-colour Patterns arranged 1 *Face*, 1 *Back in the Warp.*—The designs J, K, and L in Fig. 83 show different methods of arranging the weaves and the colours for producing the vertical hairline in four shades, with the ends arranged in the order of 1 face, 1 back. It will be noted that in J the weft colours are in the same order as the face warp colours, but in K and L the second pick is in the same colour as the third face end, and the third pick as the second face end. For the reason that each colour of weft must pass over its own colour of warp in producing the vertical hairline, the arrangement shown at J is somewhat defective, because the intersections of the face ends forms a twill line. With the double-plain weaves combined as in J, the warp-backed 3-and-1 warp twill is really formed. In the same manner K is the warp-backed 4-thread warp sateen weave. In the design L, however, the weaves are purely double plain, arranged to cut every four ends. The flat views (showing two repeats) and the sections given at J and L in Fig. 84, correspond with the weaves J and L. An examination will show that in each case vertical lines of colour in the order of 1, 2, 3, and 4 are formed on the surface.

The same remarks apply with reference to the colouring of the backing ends, as in the case of three-colour effects. If they are arranged in the order indicated above the plans, solid lines of colour will be formed on the underside. The shades in the complete warping plan for L, in Fig. 83, will then be arranged in the order of 1, 4, 2, 3, 3, 2, 4, 1.

Although in the four-colour effects the pattern is limited to single lines of each shade, considerable variety of effect can be obtained by suitably arranging the face warp colours and the weaves to correspond. For example, the design M in Fig. 83 will produce the following single-thread stripe :—

Shade 1—1.1..1.1..........
Shade 2—.1.1..1.1....1....
Shade 3—....1....1.1..1.1.
Shade 4—..........1.1..1.1

In constructing such a style, however, it is necessary to remember that when more than two colours are used, a change of colour may not cause an interchange of the picks to take place. Thus in M no interchange takes place between the shades 1 and 2 and the shades 3 and 4. Care must therefore be taken to group the shades in such a manner that the weave in any one section does not occupy too large a space, or the cloth will be liable to cockle. In making a design, each pick of weft requires first to be marked on its own colour of warp, the marks on the backing ends being then added to the best advantage. If on completing the design it is found unsatisfactory, experiments may be made in changing the order of wefting and altering the weaves to correspond.

DOUBLE TWILL AND SATEEN STRIPE DESIGNS

While the double plain, owing to the neat appearance, firmness, and good wearing quality of the cloth, is the standard weave used in the production of patterns in which each section requires to be in solid colour, similar effects may be obtained by using other double weaves. These also enable a larger number of colours to be introduced. Thus the double 3-thread twill permits of the use of six colours, the double 4-thread twill and the 4-thread sateen of eight colours; while with the double 5-thread sateen any number of colours up to 10 may be employed. In addition, if the pattern is required in large sections, firmness of structure may be obtained by tying the weaves on the ordinary principle. In small patterns, however, the interchanging of the threads where the weaves are combined gives sufficient firmness.

Numerous examples might be given to illustrate the various ways in which patterns may be formed; but since the principles involved are the same as in the construction of the double-plain effects, the examples N to Z in Fig. 85 will be sufficient for the purpose. N and O are the opposite double 3-thread twill weaves, arranged on the system in which two face or two backing ends are brought together where the weaves are combined. The weaves marks indicate weft, and the cloth is warp surface on both sides. In N the odd threads are on the surface and the even threads on the back, while in O the even threads are on the surface, and the odd threads on the back, as shown in the bottom portion of the plans, which, as before, are in three portions. Various schemes of colouring, each necessarily repeating on six threads, are indicated above and alongside the plans, each shade being represented by a different kind of mark. At P the order of colouring in warp and weft is 1-and-1 throughout; and assuming that six threads of each weave are combined in stripe form, as shown in Fig. 85, the pattern formed on the surface will be three threads of shade 1 and three threads of shade 2. Q will produce a solid coloured stripe pattern in three shades, arranged on the surface in the order of 1, 1, 2, 2, 3, 3. R is a four-colour arrangement, the shades being brought up in the order of 1, 1, 3, 2, 2, 4. S is in five shades, the order on the face being 1, 1, 2, 3, 4, 5; while T produces an effect in six shades in the order of 1, 2, 3, 4, 5, 6. In following the surface arrangement of the threads only the odd threads above the design N, and only the even threads above the design O, should be included. It will be noted in the plans that each face end passes under its own colour of weft and over the other colours, while each backing end is raised over its own colour and passes below the other colours. Solid vertical lines of colour are thus formed on both sides of the cloth. The double 3-thread weft twill weave may be arranged in the same manner to form horizontal lines.

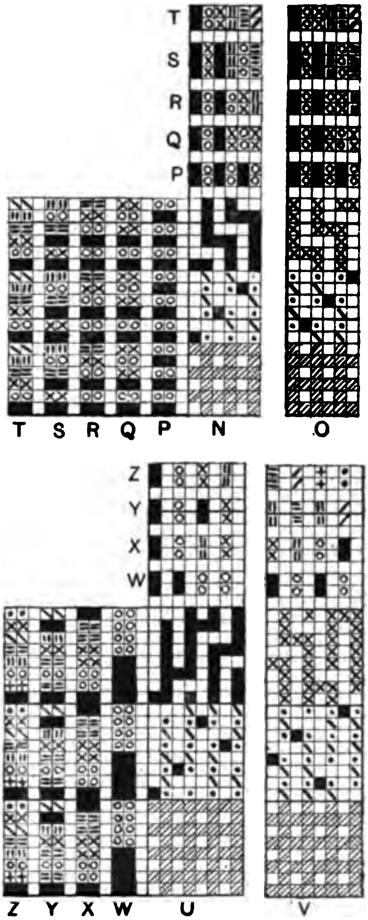


Fig. 85.

Although the list is by no means complete, the foregoing examples illustrate the diversity of effect which can be obtained in one design by varying the arrangement of the threads as to colour. In any of the schemes of colouring, however, still further diversity can be produced by varying the spaces occupied by the weaves. In addition, the weaves may be combined as in the double plains to form check and figured patterns in two or more colours.

The plans given at U and V in Fig. 85 are the opposite double 4-thread warp sateen weaves constructed on the system in which the ends are arranged 1 face, 1 back throughout. Four schemes of colouring the face ends are given above the plans at

W, X, Y, and Z, and the corresponding weft colour plans, similarly lettered, are shown alongside. It is assumed that eight threads of each weave are combined in stripe form, although, as will be understood, the space occupied by each may be varied as desired. The face warping plans indicate the colour patterns which will be formed on the surface, while the chief point to note in arranging the weft colours is that each pick passes over its own colour of warp. W is a two-colour pattern, the shades on the surface being in the order of 1, 1, 2, 2, 1, 2, 1, 2. X is in four shades in the order of 1, 2, 4, 3, 3, 4, 2, 1 ; Y in six shades in the order of 1, 2, 1, 3, 4, 5, 4, 6 ; while Z shows how a single-thread stripe in eight shades may be arranged. The colouring of the backing ends is not indicated, but if solid lines are required on the underside, each must be in the same colour as the pick over which it is raised.

CHAPTER IV

WADDED AND CENTRE-STITCHED DOUBLE CLOTHS AND TREBLE CLOTHS

Wadded Double Cloths—Weft-Wadded Double Cloths—Warp-Wadded Double Cloths. *Centre-Stitched Double-Cloth Designs*—Centre Warp Stitching—Centre Weft Stitching. *Treble Cloths*—Systems of Stitching—Treble Cloth Designing in Stages—Construction of Drafts and Pegging Plans—Systematic Construction of Treble-Cloth Designs—Use of Centre Fabric as Wadding.

WADDED DOUBLE CLOTHS

A WADDED double cloth consists of a face and a back fabric, tied together by floating backing ends over face picks, or backing picks over face ends, as in ordinary double cloths, with the addition of a special series either of weft or warp threads introduced independently of the face and backing yarns. The weft-wadded cloths thus consist of three series of weft and two series of warp threads, while in the warp-wadded cloths there are three series of warp and two series of weft threads. The wadding threads lie between the two fabrics, and are visible neither on the face nor back ; hence a thicker and cheaper yarn than that used for the face and back may be employed for wadding without the appearance of the cloth being affected. The principle is therefore useful in cases where increased weight and substance are required to be economically obtained in conjunction with a fine face texture. The wadding threads may be introduced into any arrangement of the face and backing threads, but the common proportions are 1 wadding to 1 face and 1 back, 2 face and 2 back, or 2 face and 1 back. The first arrangement is suitable when the wadding yarn is not much thicker than the face yarn, and the second and third when very thick wadding is used.

Weft-Wadded Double Cloths.—The construction of designs for these cloths is illustrated by the examples given in Figs. 86 and 88, in which the marks indicate weft. In each figure, A is the plan of the face weave, and B of the backing weave, while the marks between the squares indicate the positions of the ties. Since the wadding yarn simply lies between the two fabrics without interweaving with either (being retained in position by the passing of the face and backing threads from one fabric to the other where the ties occur), the same conditions are necessary, so far as regards the face weave, the ties and the backing weave, as in the construction of ordinary double cloths. The wadded design is therefore exactly the same as the double design except for the inclusion of the wadding threads; and in order that comparisons may be made, the double weave without the wadding threads is given at C. D shows the first stage in the construction of the wadded double-cloth design, the positions of the backing and wadding threads being indicated by the shaded lines. Diagonal strokes are used for shading on the backing threads and vertical strokes on the wadding threads, a convenient method in practice consisting of using different colours. In the complete design, given at E the full

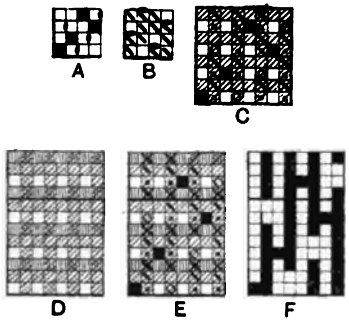


Fig. 86.

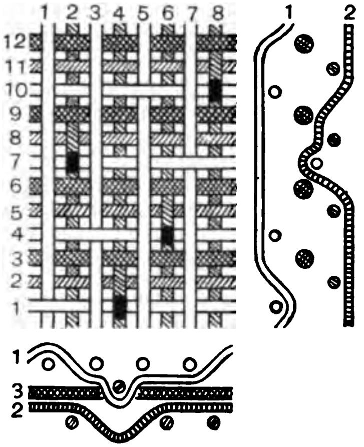


Fig. 87.

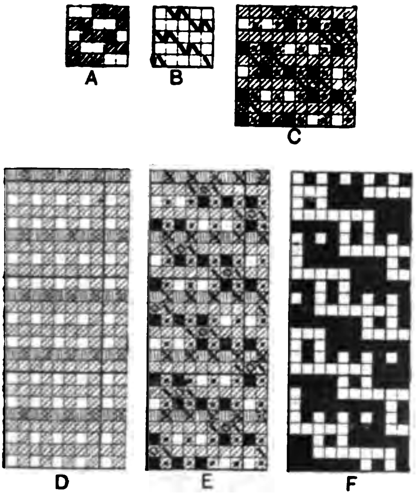


Fig. 88.

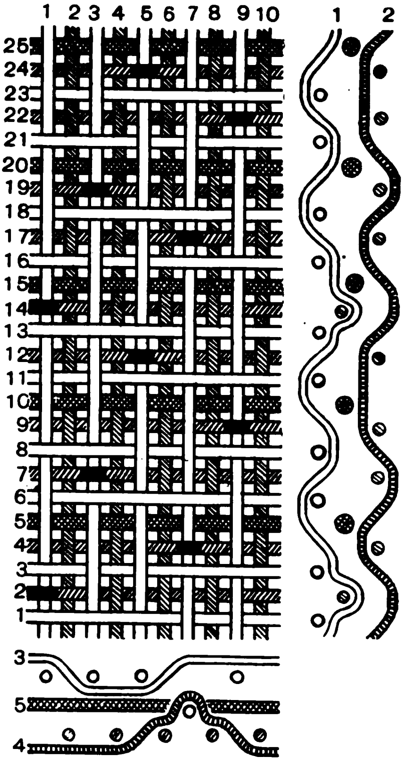


Fig. 89.

squares indicate the face weave, the circles the ties, the diagonal marks the backing weave, the dots the backing ends down on the face picks, while crosses are inserted to show the interweaving of the wadding threads. All the marks indicate weft, except where circles are used for the backing warp ties. F is similar to E, but only one kind of mark is used to indicate where the weft is on the surface.

In the diagrams given in Figs. 87 and 89, which correspond with the complete designs shown in Figs. 86 and 88 respectively, the backing and wadding threads are shaded in different ways in order that they may be readily distinguished. The wadding threads are also represented as being of larger diameter than the face and backing threads. In the flat views the threads, for convenience, are placed alongside each other at approximately uniform distances apart in the same order as in the designs. The positions of the ties are indicated by the solid marks.

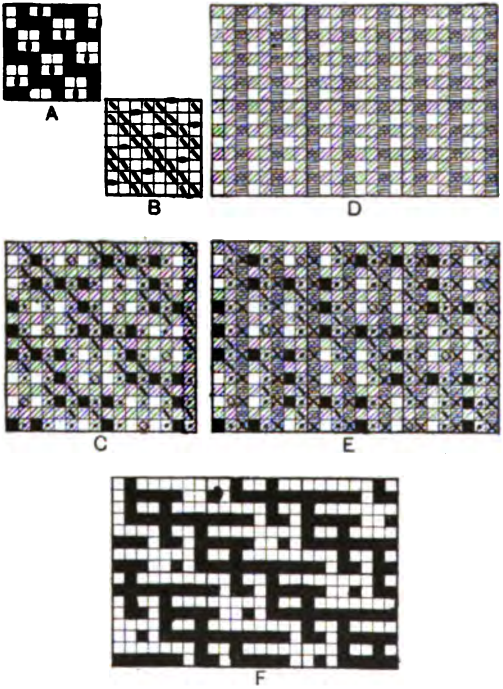


Fig. 90.

In the example given in Fig. 86 the picks are arranged in the order of 1 face, 1 back, 1 wadding; and the ends 1 face, 1 back. The 4-thread sateen weave, warp surface on both sides of the cloth, is employed, the tying being effected by raising the backing ends in 4-thread sateen order over the face picks. In the corresponding drawings, given in Fig. 87, the section on the right of the flat view shows the interweaving of the ends 1 and 2, and that below of the picks 1, 2, and 3.

In Fig. 88 the ends are arranged 1 face, 1 back, but there are two face and two backing picks to each wadding pick. The 5-shaft Venetian weave, weft surface on both sides of the cloth, is employed, the tying in this case being effected by passing the backing picks in 5-sateen order over the face ends. It will be noted that the arrangement renders it necessary for the design E to include two repeats of the double weave. In the corresponding drawings, given in Fig. 89, the section on the right of the flat view shows the interweaving of the ends 1 and 2, and that below of the picks 3, 4, and 5.

In the weft wadded cloths the only point to note, in addition to the correct construction of the double weave, is that marks are inserted where the wadding picks intersect the backing ends, as shown by the crosses in the designs lettered E in Figs. 86 and 88. All the face ends are thus raised, and the backing ends depressed when the wadding weft is inserted, as is distinctly shown in the flat views in Figs.

87 and 89. On the other hand, if warp is indicated in the designs, marks require to be inserted where the wadding picks intersect the face ends.

Warp Wadded Double Cloths.—The wadding yarn is more economically and conveniently introduced in the warp than in the weft principle, but the greater strain put on the threads in weaving necessitates the use of a better quality of wadding material. The construction of the designs is illustrated in Figs. 90 and 92, in which the marks again indicate weft. The face and back weaves are given at A and B respectively in each figure, while for the purpose of comparison the double weave, without the wadding ends, is indicated at C. The arrangement of the threads in the warp-wadded design is illustrated at D, the horizontal strokes indicating the wadding ends. The complete design is given at E, in which the same marks are used as in the weft-wadded designs, while F shows the design indicated in one kind of mark.

In Fig. 90 the ends are arranged in the order of 1 face, 1 back, 1 wadding; and the picks 1 face, 1 back. An 8-thread twilled hopsack weave is employed for the face fabric, and a 2-and-2 twill for the back, and the backing ends are raised for tying in 8-sateen order. The drawings in Fig. 91 correspond with the design E in Fig. 90, the section on the right of the flat view showing the interweaving of the ends 1, 2, and 3, and that below of the picks 1 and 2.

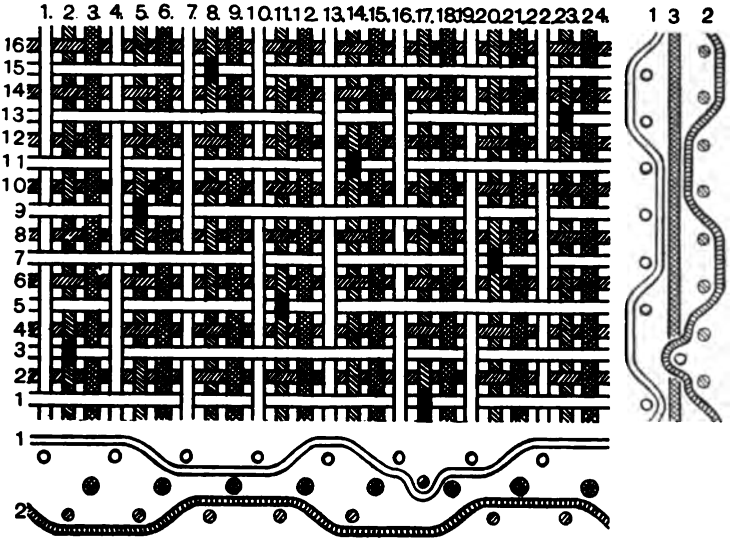


Fig. 91.

The warp in Fig. 92 is arranged in the order of 1 face, 1 back, 1 face, 1 wadding; and the weft 1 face, 1 back, 1 face, the arrangement permitting of the use of much thicker backing and wadding than face yarn. The face weave is a 3-and-3 twill, and the backing weave a 2-and-1 twill; the two fabrics are tied together by raising each backing end over two consecutive face picks. In the corresponding drawings given in Fig. 93, the section on the right of the flat view shows the interweaving of the ends 2, 3, and 4, and that below of the picks 1 and 2. An examination of the designs E in Figs. 90 and 92 will show that, so far as the wadding ends are concerned, marks are inserted where they intersect the face picks. All the face picks thus pass over, and all the backing picks pass under, the wadding ends, as shown in the flat views in Figs. 91 and 93. If, however, warp is indicated in the designs, marks are inserted where the wadding ends intersect the backing picks.

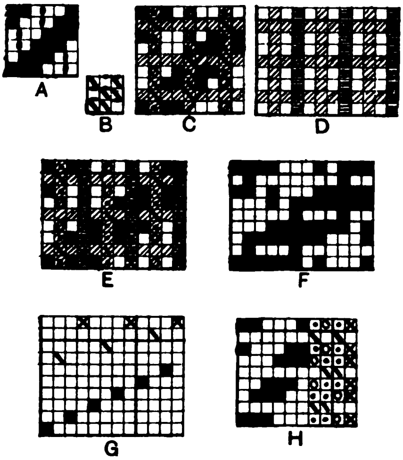


Fig 92.

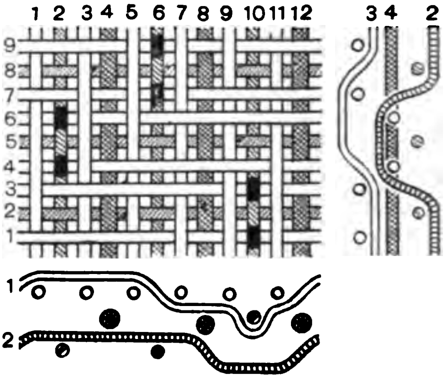


Fig. 93.

The draft for the design E in Fig. 92 is given at G, and the pegging plan at H. The wadding ends only require one heald, since they all work alike; but in fine setts, in order to avoid crowding the heald, they may be drawn on to two or more healds, which are then operated as one.

CENTRE-STITCHED DOUBLE CLOTHS

It has been shown that in wadding a cloth the chief object is to get a heavy structure by introducing a centre yarn which is usually thicker and cheaper than the face and backing yarns. In centre stitching, however, although the threads may be introduced in the same order as in wadding, and additional weight thereby be obtained, the specific purpose is to bind the two fabrics together with the centre threads, which as a rule are finer than either the face or backing threads. In this system the threads of one fabric do not interweave with those of the other fabric; the centre threads pass alternately from one to the other, and lie between them when not employed for tying. It is a useful method for cloths in which there is a great difference either in the thickness or the colours of the yarns used for the face and back, as, for example, for overcoatings in which a check lining is woven with the face fabric, and for heavy cloaking and mantle cloths which are made with coloured checks on one side and solid shades on the other. In such cloths the ordinary method of tying is not suitable, as the contrast in colour and the difference in thickness between the face and backing yarns make the ties liable to show.

In the accompanying designs and diagrams (Figs. 94 to 100) the backing and stitching threads are shaded in different ways, while, in addition, in the diagrams the centre threads are represented as being of smaller diameter than the face and backing threads. In the flat views the threads are shown alongside each other in the same order as in the plans, the solid marks indicating the positions of the ties. The face and backing weaves, with the positions of the ties indicated between the squares, and a plan showing the positions of the backing and stitching threads, are given separately for each example. In the complete designs the full squares indicate the face weave, the diagonal marks inclined to the left the backing weave, and the dots the backing ends down on the face picks. On the centre threads a circle indicates a thread lifted, and a cross a thread depressed for tying; while diagonal marks inclined to the right are inserted where the stitching-threads are required to lie between the two fabrics. All the weave marks indicate weft, with the exception of the circles.

Centre Warp Stitching.—The plans in Fig. 94 are illustrative of the construction of double cloths arranged 1 face, 1 back, in which the two fabrics are stitched together by means of centre warp. The design D is a double 2-and-2 twill, the face weave being as at A, and the backing weave as at B, while the ends are arranged in the proportion of 4 face and 4 backing to 1 stitching, as indicated at C. The drawings in Fig. 95 correspond with the design D, the section on the right of the flat view showing the interweaving of the ends 7, 8, and 9, and that below of the picks 2 and 3.

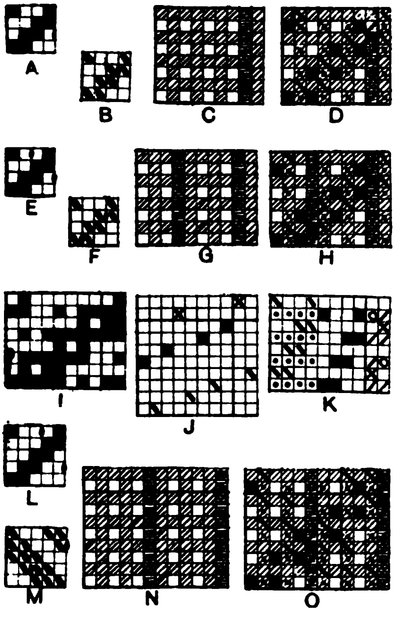


Fig. 94.

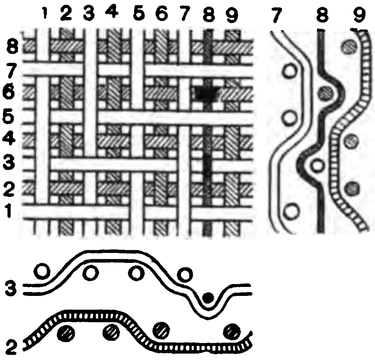


Fig. 95.

As each repeat of the double weave given at D contains only one stitching end, the ties always occur in the same line, both on the face and back of the cloth.. A better arrangement is given in the design H, in Fig. 94, in which the ends are in the proportion of 2 face and 2 backing to 1 stitching, as shown at G. The face weave is given at E, and the backing weave at F. In this case there are two centre stitching ends in one repeat of the double weave, which not only causes the fabrics to be more firmly united, but enables an alternate distribution of the ties to be made. This is clearly shown in the corresponding flat view given in Fig. 96. The section on the right of the flat view shows the interweaving of the ends 3, 4, and 5, and that below of the pick 2 and 3.

An examination of the designs D and H in Fig. 94, and a comparison with the corresponding diagrams in Figs. 95 and 96, will show that in centre warp stitching it is necessary for the following to be observed :—(*a*) In tying to the face fabric the centre ends are floated over the face picks in places where a face end is raised on each side, as shown by the circles in the plans. (*b*) In tying to the back fabric the centre ends are depressed on the backing picks in places where a backing end is down on each side, as shown by the crosses. (*c*) Where no ties occur, the face picks pass over and the backing picks pass under the centre ends; thus marks are inserted where the face picks and the centre ends intersect, except where there are circles. If warp is indicated marks are inserted where the centre ends intersect the backing picks.

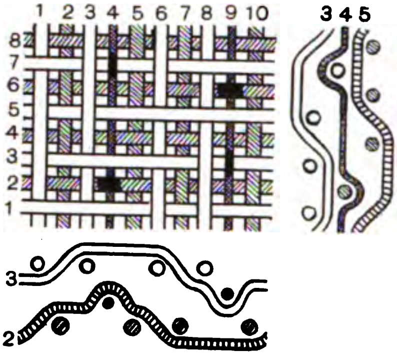


Fig. 96.

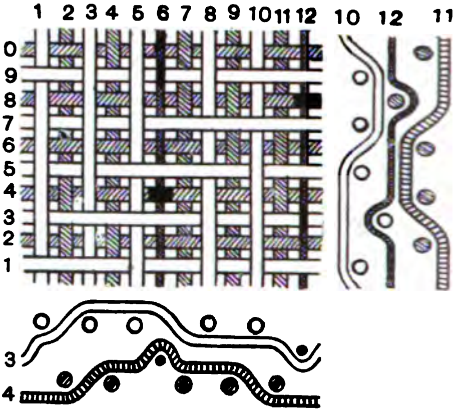


Fig. 97.

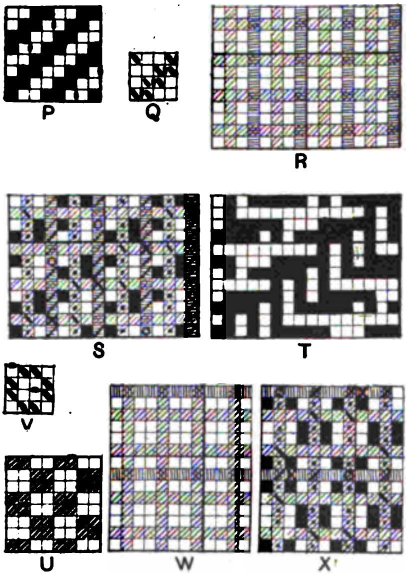


Fig. 98.

The design I in Fig. 94 shows the appearance of the weave H when only one kind of mark is used to indicate where the weft is on the surface. The draft is given at J, and the pegging plan at K, the blanks and circles in the latter indicating the healds lifted. Since the stitching ends are usually strong enough to withstand considerable strain in weaving, they may be drawn on to the healds which are farthest from the front, as shown by the crosses in J.

The design O, in Fig. 94, is the double 3-warp and 2-weft twill weave with two stitching ends in each repeat, as shown at N. In this example the face and backing weaves (given at L and M respectively) are so arranged that the direction of the twill line when the piece is turned over is the same as on the face side, the cloth being thus perfectly reversible. The corresponding drawings are given in Fig. 97, the section on the right of the flat view showing the interweaving of the ends 10, 11, and 12, and that below of the picks 3 and 4. As shown here, in centre-stitched cloths the backing weave requires to be placed in such a position in relation to the face weave that the ties on each stitching thread will be about half the repeat distant from each other. Thus the second stitching end (end number 12) in Fig. 97 is raised for tying on the third pick, and depressed half the repeat distant on the eighth pick.

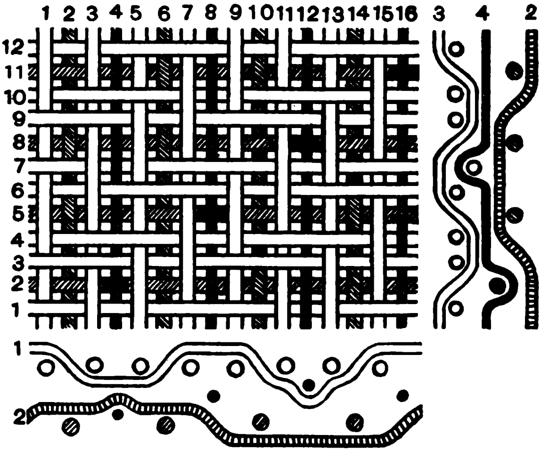


Fig. 99.

An example is illustrated at P to T in Fig. 98, in which the proportion of face threads to backing threads is 2 to 1, an arrangement which permits of the use of very thick yarns in the under-fabric. S is a double 2-and-2 twill, with the face weave as at P, and the backing weave as at Q. The tying is effected by means of four centre ends in the repeat, the complete order of warping being 1 face, 1 back, 1 face, 1 centre, as shown at R. The plan with only one kind of mark used to indicate where the weft is up is given at T. The corresponding drawings are given in Fig. 99, the interweaving of the ends 2, 3, and 4 being shown on the right, and of the picks 1 and 2 below the flat view. The example shows how a tartan-lined cloaking cloth is constructed. The tartan-check side is composed of the finer yarns, and is taken as the face in weaving, although in the made-up garment it forms the back; while the solid side consists of the coarser fabric which forms the back in weaving and the face when made up.

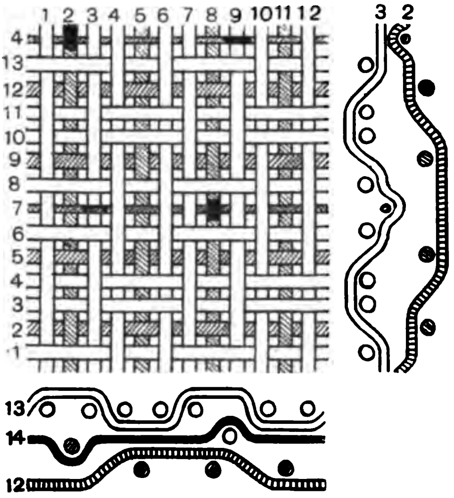


Fig. 100.

Centre Weft Stitching.—The plans U to X in Fig. 98 illustrate the principle of stitching by means of centre weft. The double 2-and-2 hopsack weave is employed, the face weave being given at U and the backing weave at V. The picks are in the proportion of 4 face and 2 backing to one stitching as indicated at W, one repeat of the double weave thus containing two centre picks. The complete design is given at X, and in the corresponding diagrams represented in Fig. 100, the interweaving of the ends 2 and 3 is shown alongside, and of the picks 12, 13, and 14 below the flat view. In this system it is necessary that the following be observed:—(*a*) In tying to the face fabric the centre picks are passed over the face ends in places where there is a face weft float on each side, as shown by the crosses in X. (*b*) In tying to the back fabric the centre picks pass under the backing ends in places where, on the underside, there is a backing weft float on each side, as shown by the circles. (*c*) Where no ties occur the centre picks pass under the face ends and over the backing ends; thus diagonal marks (to the right) are shown where the backing ends and the centre picks intersect, except where circles are inserted. In marking for warp, the diagonal strokes will be indicated where the face ends and centre picks intersect.

TREBLE CLOTHS

In treble cloths there are three series of warp and weft threads which form three distinct fabrics, one above the other. Except for the ties, when a face pick is inserted all the centre and backing ends are left down; when a centre pick is inserted all the face ends are raised, and all the backing ends are left down; while when a backing pick is inserted, all the face and centre ends are raised. The face ends and picks interweave with each other to form the face fabric, the centre ends and picks to form the centre fabric, and the backing ends and picks to form the back fabric. By interweaving the centre ends or picks with the face and backing picks or ends, the three fabrics are joined together, and the resulting cloth is equal in thickness and weight to the three single fabrics. Greater weight combined with equal fineness of appearance can thus be obtained in this than in the double system of construction. The weight of double-woollen structures is frequently increased by excessively shrinking the cloth in the felting process, the chief disadvantage of which is that its elasticity is liable to suffer. This does not occur when increased weight is obtained by making the cloth three-fold, hence the treble principle can be advantageously employed in preference to the double system in adding weight to cloths which require little shrinking in the finishing processes.

The chief factors which it is necessary to observe in the construction of treble-cloth designs are illustrated by the plans in Fig. 101, and the diagrams in Figs. 102 and 102A. The threads are arranged 1 face, 1 centre, 1 back, and the 2-and-2 twill is employed for each fabric, the face weave being as at A, the centre weave as at B, and the backing weave as at C in Fig. 101. The ties are distributed in 8-thread sateen order.

The complete designs H, I, J, and K, in Fig. 101, are alike, except that different methods of effecting the tying are employed. In order that comparisons may be made, the plans A, B, and C, with the position of the ties indicated by the marks between the squares, are shown on the left of each complete design. In Fig. 101 the centre and backing threads are shaded in different ways (horizontal strokes being used for the centre threads, and diagonal strokes for the backing threads). The following marks are employed:—Full squares for the face weave, diagonal marks inclined to the right for the centre weave, diagonal marks inclined to the left for the backing weave, dots to indicate the centre ends down on the face picks, and the backing ends down on the face and centre picks, circles to show where the centre is tied to the face, and crosses where the centre is tied to the back. The circles and crosses indicate weft in one case and warp in another, but the other marks indicate weft.

In the drawings given in Figs. 102 and 102A the centre and backing threads are shaded in different ways, but in order that they may be readily distinguished,

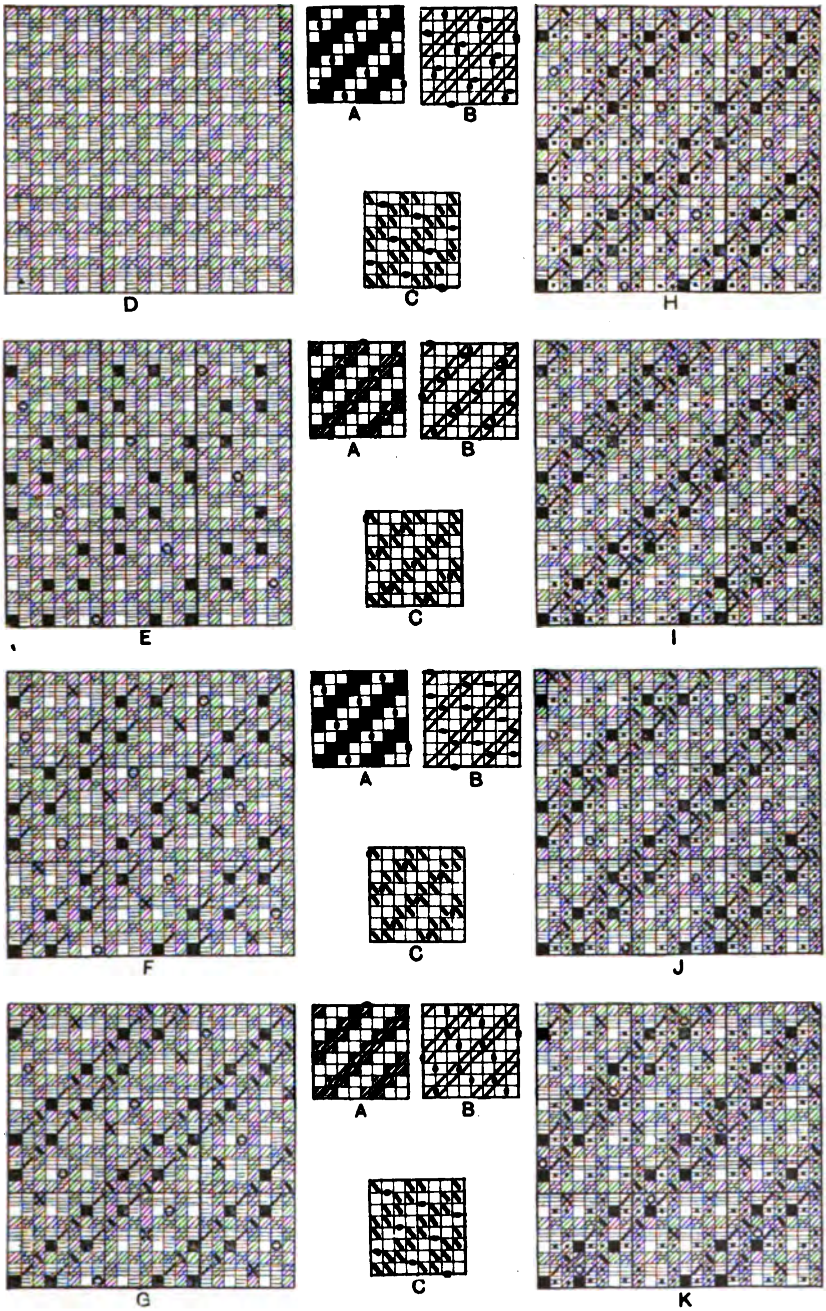


Fig. 101.

the backing threads are represented as being of larger diameter than the centre threads, and smaller than the face threads. The flat view in Fig. 102 corresponds with the design H in Fig. 101, the solid marks indicating the positions of the ties. The sections H, I, J, and K below the flat view respectively show the interweaving of the picks 1, 2, and 3 of the designs similarly lettered in Fig. 101, while in the same manner those given in Fig. 102A show the interweaving of the ends 1, 2, and 3.

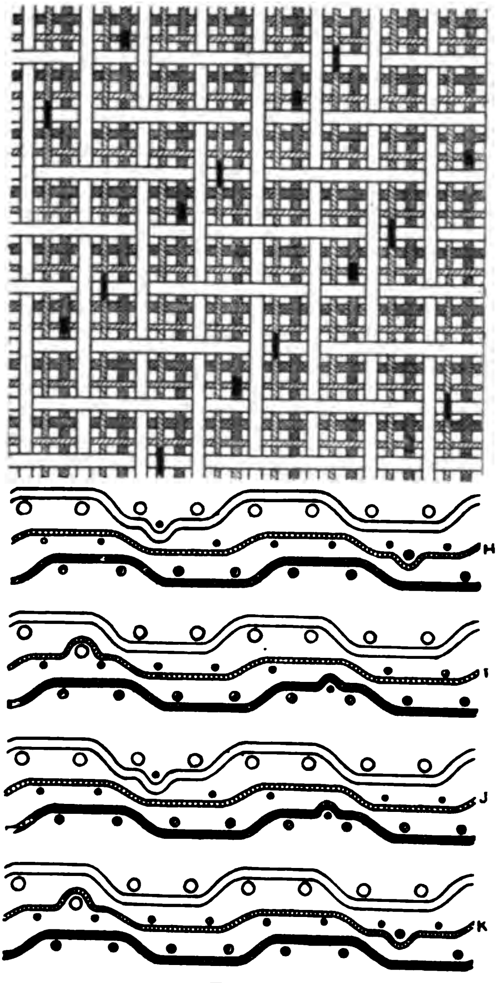


Fig. 102.

Systems of Stitching. — The principle of tying is the same as in ordinary double cloths—that is, each tie on the face and back should be covered on both sides by corresponding floats. There are four ways in which the tying may be effected by the centre yarns :—(1) As shown at H in Figs. 101, 102, and 102A, by passing the centre ends over the face picks, and the centre picks under the backing ends. (The circles and crosses in the design H thus indicate warp up.) (2) As shown at I, by passing the centre picks over the face ends, and the centre ends under the backing picks. (Here the circles and crosses indicate weft up.) (3) As shown at J, by passing the centre ends over the face picks and under the backing picks. (In this case the circles indicate warp and the crosses weft up.) (4) As shown at K. by passing the centre picks over the face ends and under the backing ends, the circles thus indicating weft and the crosses warp up. The method of tying which is most suitable is mainly decided by: (*a*) The positions of convenient binding places in the face and backing weaves; and (*b*) the thickness and quality of the centre yarns, compared with the face and backing yarns. The first method, illustrated by the design H in Fig. 101, is most commonly employed, but the centre yarn—warp or weft—which is the finer and smarter, should be used if possible, particularly in tying to the face.

If an examination of the drawings H, I, J, and K in Figs. 102 and 102A be made. it will be noted that while the centre threads enter both the face and back fabrics, the face and backing threads enter the centre fabric. Thus in H the face picks and backing ends tie with the centre fabric, in I the face ends and backing picks, in J the face and backing picks, and in K the face and backing ends. So far as regards the appearance of the cloth, the position of the ties in the centre fabric is of no importance. It is necessary, however, for care to be taken that none of the floats in the centre fabric are broken by the ties, as this results in the cloth being harder woven, and may cause the wefting capacity of the fabric to be seriously affected. The most perfect conditions prevail when the ties in the centre are between corresponding floats, the same as in the face and back. The following rule will enable the best possible conditions to be obtained, assuming that weft is indicated :—Where an end is raised for tying (whether centre or backing), if possible the tying mark should be placed between two blanks alongside each other of the weave to which the tie is made, and should be preceded and followed by blanks on its own picks, as shown in H. Where a pick is floated for tying (whether centre or backing), if possible the tying mark should be preceded and followed by marks of the weave to which the tie is made, and be placed between two marks alongside each other, on its own ends, as shown in I. If warp is indicated the conditions are the reverse of the foregoing.

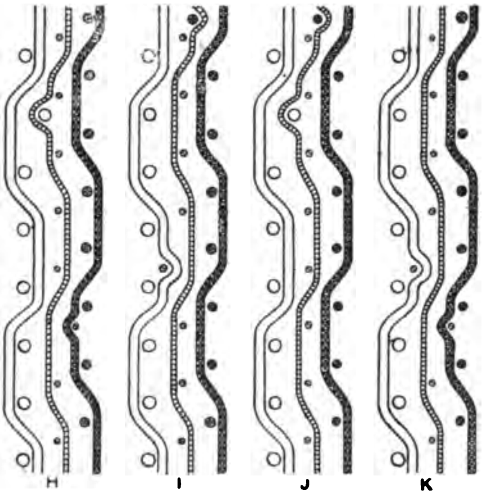


Fig. 102A.

Treble Cloth Designing in Stages.—The plans D to H in Fig. 101 show how the different stages in the construction of a treble-cloth design may be conveniently arranged in working according to the foregoing rule. At D the arrangement of the threads is indicated. At E the face weave is shown inserted on the squares where the face ends intersect with the face picks. At this stage the positions of the centre ties in relation to the face weave are indicated, as shown by the circles. At F the centre weave is inserted on the squares where the centre ends and picks intersect, and in a suitable position in relation to the circles. The ties which bind to the back are then indicated as shown by the crosses, their positions being determined by the positions of suitable binding places in the centre weave. At G the backing weave is inserted on the squares where the backing ends and picks intersect, and in a suitable position in relation to the crosses. At H the design is completed by marking down the centre ends on the face picks, and the backing ends on the face and centre picks, except where ties are placed.

An examination and comparison of the designs will show that in tying to the face, in H and J each centre warp tie is indicated where a centre end intersects a face pick, and in I and K each centre weft tie where a centre pick intersects a face end. In tying to the back, in H and K each centre weft tie is indicated where a centre pick intersects a backing end, and in I and J each centre warp tie is shown where a centre end intersects a backing pick.

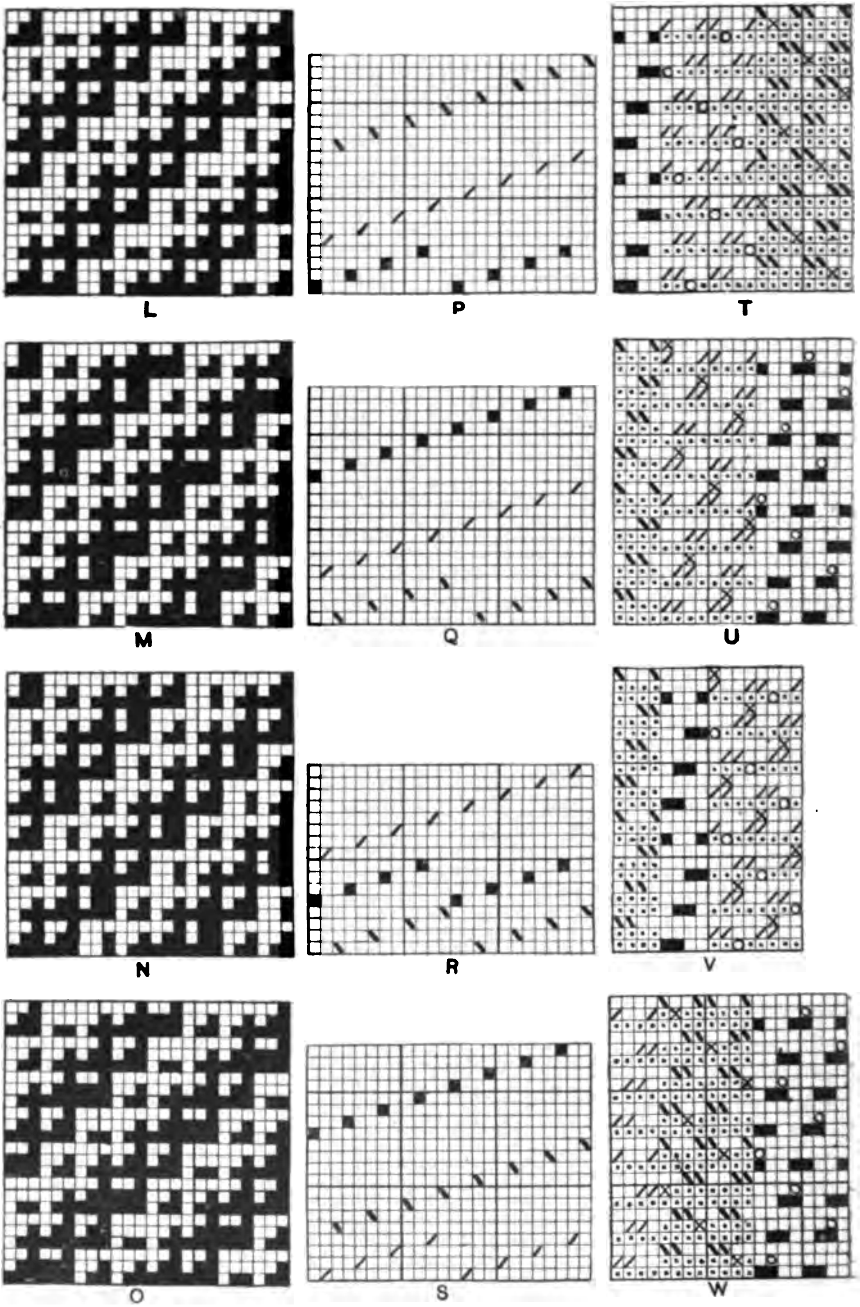


Fig. 103.

The plans L, M, N, and O in Fig. 103, which respectively correspond with the plans H, I, J, and K in Fig. 101, will enable further comparisons to be made, since they show how the weaves appear when only one kind of mark is used to indicate where the weft is up.

Construction of Drafts and Pegging Plans.—The respective drafts for the designs H, I, J, and K in Fig. 101 are given at P, Q, R, and S in Fig. 103, and the pegging plans at T, U, V, and W. Three sets of healds are necessary, and in deciding upon their positions the rule has been followed of placing the most crowded healds at the front, with the face healds preferably behind those which are equal to them in fineness. Thus, taking the healds in order from front to back, the design H requires 4 face, 8 centre, and 8 backing healds ; I, 4 backing, 8 centre, and 8 face healds ; J, 4 backing, 4 face, and 8 centre healds ; and K, 4 centre, 8 backing, and 8 face healds. Two other arrangements of the sets of healds are possible—viz., the centre healds at the front of, and the backing healds behind, the face healds ; and the face healds at the front of, and the centre healds behind, the backing healds. Other factors which require to be considered in deciding upon the positions of the respective sets of healds are the relative strengths and intersections of the face, centre, and backing yarns. Other things being equal, the weakest yarns should be drawn on the healds at the front, and in the same manner the threads which interweave the most frequently. The given drafts show the designs reduced to the lowest possible number of healds, but for such an example it would usually be more convenient to use 8 healds in each set, in order to simplify the drawing in, and so that changes could be readily made either in the system of tying, or in the positions of the healds. In the pegging plans all the marks indicate healds down, except where a dot is replaced by a circle or a cross.

Systematic Construction of Treble-Cloth Designs.—The foregoing example shows that when the same weave is used throughout, and the threads are arranged in equal proportions, favourable conditions for tying are obtained by commencing the weave always in the same relative position. The weft and warp floats on the upper surfaces of the centre and back fabrics respectively are then directly below the warp and weft floats on the under-surface of the face and centre fabrics, hence there is no obstacle to the interweaving of the threads of one fabric with those of another. When different weaves are employed, however, it is necessary for their positions to be found by experiment. If the treble design is constructed directly, this is not always an easy matter, while, in addition, on the extended design it is frequently difficult to judge when the best results are obtained. A system of working which enables the most perfect relation of the weaves and the ties to each other to be conveniently found before the design is commenced, is shown at A to F in Fig. 104. The principle is similar to that described and illustrated in reference to the construction of double-cloth designs (see p. 55) ; therefore only a brief description is given here. A 4-thread sateen weave, warp surface, is used for the face fabric, a 2-and-2 twill for the centre fabric, and a 4-thread sateen, with the weft on the underside for the back fabric, the weave marks indicating weft up. The threads are arranged 1 face, 1 centre, 1 back, as shown at G, and the tying is effected by passing the centre ends over the face picks, and the centre picks under the backing ends. At A the face weave is inserted, and the positions of the centre ends, between the face ends, are indicated along the bottom, and of the centre warp ties between blank squares of the face weave. At B the positions of the face picks, between the centre picks, are indicated at the side of the space reserved for the centre weave, and the face weft ties are copied from A and marked between the squares. At C the centre weave is inserted, care being taken that weave marks do not occur both above and below a tying mark. Experiment will show that no other position of the 2-and-2 twill is suitable. At D the centre weave is copied from C, and the positions of the backing ends between the centre ends are indicated along the bottom. The places where the backing ends may be conveniently raised to tie with the centre weave are then indicated, as shown by the marks between the squares of D. At E the positions of the centre picks, between the backing picks, are indicated at the side of the space reserved for the backing weave, and the centre weft ties are copied from D. At F the backing weave is inserted, if possible with a blank square above and below each tying mark. The complete design (given at H) can now be readily constructed from the plans A, C or D, and F, with the certainty that the conditions of a perfect treble cloth will be secured.

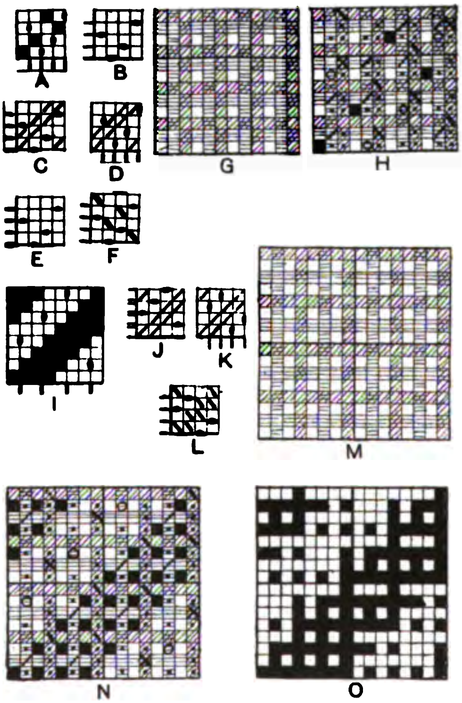


Fig. 104.

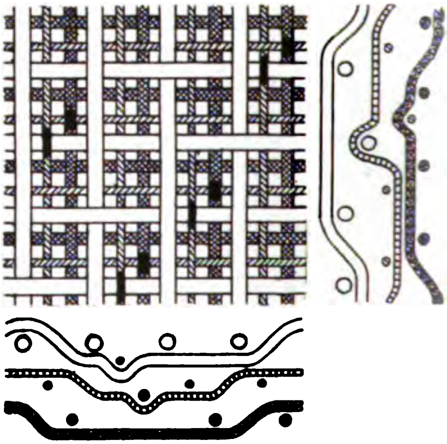


Fig. 105.

The flat view given in Fig. 105 corresponds with the design H in Fig. 104, while the interweaving of the picks 1, 2, and 3 is shown below, and of the ends 1, 2, and 3 alongside the flat view. (The weave marks and the shading are the same as in the examples given in Figs. 101 and 102.) It will be noted that the solid marks in the flat view correspond with the circles and crosses in the design H. The section below the flat view shows how the second centre end is raised for tying on the first face pick, and the second backing end on the first centre pick; while in the section alongside the first centre end is shown passing over the third face pick, and the first backing end over the third centre pick. A comparison of the flat view with the plans A to F will enable the different stages of working to be more readily followed. Thus it will be seen that where there are solid marks on the centre ends in the flat view, there are corresponding marks between the ends of plan A and between the picks of plans B and C. The former show where the centre ends are tied to the face, and the latter where the face picks are tied to the centre. In the same manner, where there are solid marks on the backing ends in the flat view, there are corresponding marks between the ends of plan D, and between the picks of plans E and F, the former indicating where the backing ends are tied to the centre, and the latter where the centre picks are tied to the back. It will be noted that while in the face and back fabrics the ties are covered on both sides, in the centre some of the ties have a corresponding float on one side only. The

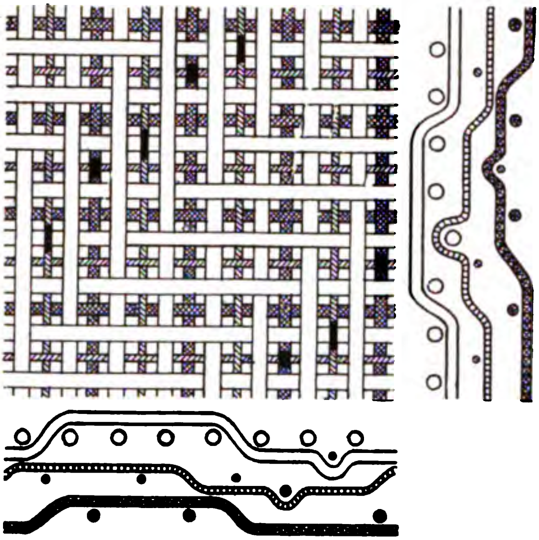


Fig. 106.

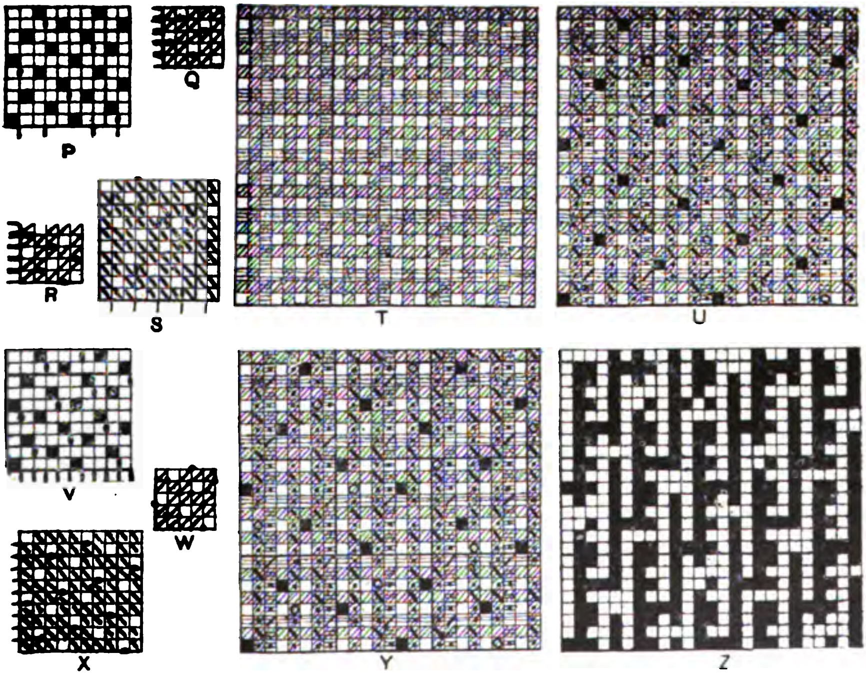


Fig. 107.

arrangement, however, is the best possible, and is not defective, because the floats of the centre ends are not broken.

The plans I to N in Fig. 104 show the working out of a treble-cloth design, in which the threads are arranged in the order of 1 face, 1 centre, 1 face, 1 back, as indicated at M. A 4-and-4 twill is used for the face fabric, and a 2-and-2 twill for the centre and back fabrics, the method of tying being the same as in the last example. The face weave, with the positions of the centre warp ties indicated between the squares, is given at I; the centre weave, with the positions of the face weft ties, at J, and of the backing warp ties at K; while the backing weave, with the positions of the centre weft ties, is shown at L. The plans I, J, K, and L, thus respectively correspond, as regards the system of working, with the plans A, C, D, and F, the only difference being that there are two face threads to each centre thread, as indicated at the side of J. The complete design is given at N and O, the latter showing the appearance of the weave when only one kind of mark is used to indicate where the weft is up. The corresponding drawings are given in Fig. 106. In the section below the flat view, which shows the interweaving of the picks 2, 3, and 4, it will be noted that the fourth centre end is raised for tying on the second face pick, and the third backing end on the first centre pick. The section alongside the flat view shows the interweaving of the ends 2, 3, and 4, the first centre end passing over the fourth face pick, and the first backing end over the third centre pick.

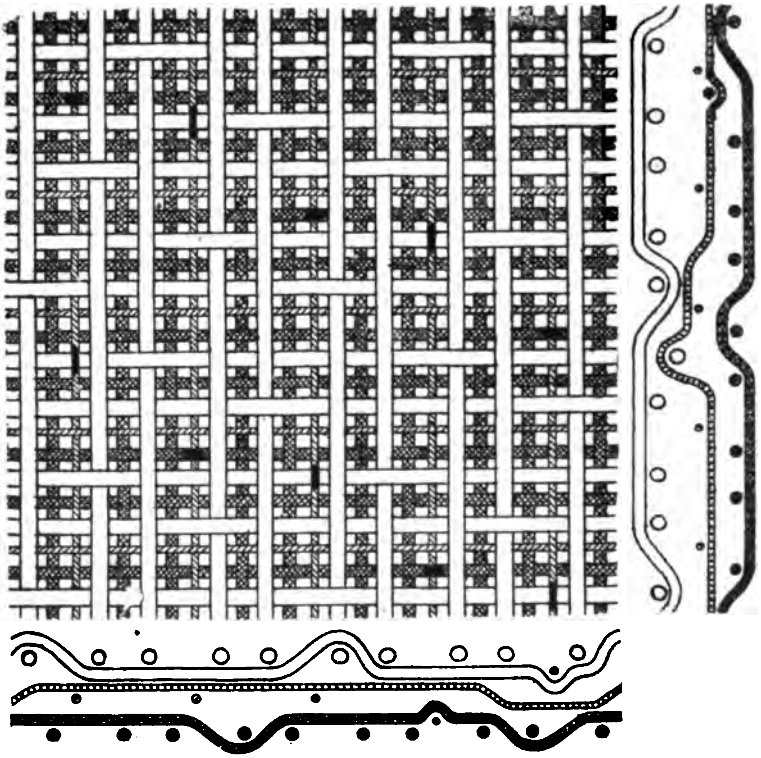


Fig. 108.

The plans in Fig. 107 illustrate the construction of a treble cloth, in which there are 2 face and 2 backing threads to 1 centre thread, the arrangement being 1 face, 1 back, 1 centre, 1 face, 1 back, as shown at T. Five-thread sateen weaves are used for the three fabrics, the cloth being warp surface on both sides, or reversible, while the centre fabric has the weft float on the upper surface. For the purpose of illustration two different principles of joining the three fabrics together are given. In the complete design, shown at U, the tying is effected by the centre ends interweaving with both the face and backing wefts, this being a suitable method for the reversible warp surface, while it is also very applicable to structures in which the centre warp is not much thicker than the face and backing yarns, whereas the centre weft is much thicker. P, shows the face weave with the positions of the centre warp ties indicated; Q, the centre weave with the face weft ties; R, the centre weave with the backing weft ties; and S, the backing weave with the centre warp ties. It will be noted that the weaves and ties are arranged in such positions in relation to each other that (1) the ties both on the face and back are between corresponding floats, and (2) the floats in the centre are not interfered with by the interweaving of the face and backing picks with the centre ends. This may be readily seen if the drawings given in Fig. 108 are examined and compared with the design U with which they correspond. The section below the flat view shows the interweaving of the picks 1, 2, and 3, and that alongside of the ends 1, 2, and 3.

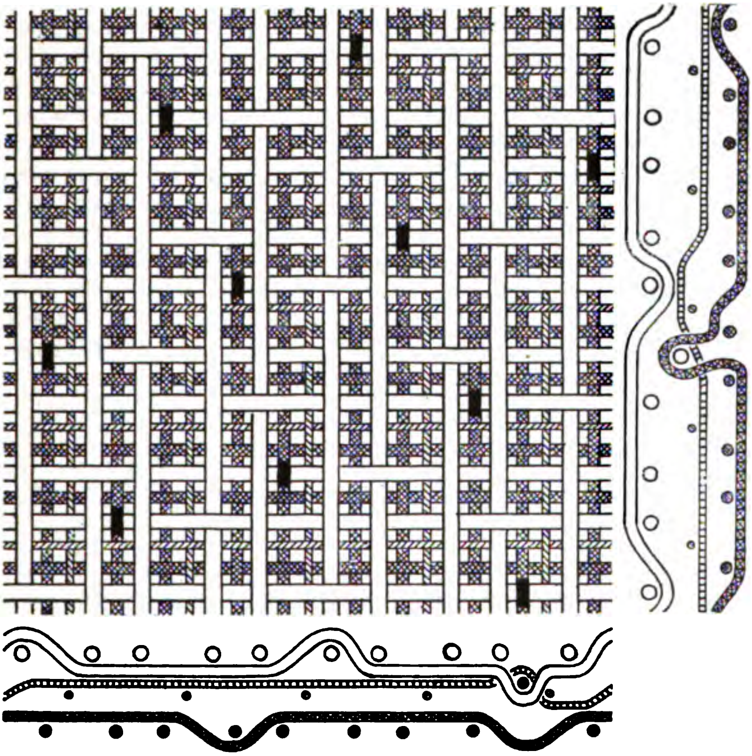


Fig. 109.

Use of Centre Fabric as Wadding.—The design Y in Fig. 107 and the corresponding drawings in Fig. 109, show a method of uniting the three fabrics which is different from any of the foregoing. In this case the centre threads do not interweave with either the face or the backing threads, but are used purely in forming a wadding cloth, the tying being effected by passing the backing ends over the face picks in 10-thread sateen order. The system can be advantageously used when the centre yarns are of lower quality and much thicker than the face and backing yarns. In arranging the positions of the weaves and ties it is only necessary to consider the face and back fabrics, as in ordinary double cloths. Thus, V shows the face weave with the positions of the backing warp ties indicated between the squares, and X the backing weave with the positions of the face weft ties indicated. The centre weave is given at W, and in order that comparisons may be made, the positions where the backing ends and picks interweave through the centre fabric, are indicated by the marks at the corners of the squares. The circles in the design Y indicate the positions of the ties, while Z shows the appearance of the weave when only one kind of mark is used to show weft up.

An examination of the flat view in Fig. 109 will show that the centre ends and centre picks interweave only with each other. The interweaving of the picks 1, 2, and 3 is shown below the flat view, and it will be noted that the first face pick passes under the ninth backing end between the fourth and fifth centre ends. In the section alongside the flat view, which shows the interweaving of the ends 1, 2, and 3, it will be seen that the first backing end passes over the fifth face pick between the second and third centre picks. The tying may also be similarly effected by the interweaving of the backing picks with the face ends.

CHAPTER V

EXTRA WEFT FIGURING

Principles of Figuring with Extra Materials—Methods of Introducing Extra Figuring Threads—Methods of Disposing of the Surplus Extra Threads. FIGURING WITH EXTRA WEFT—Continuous Figuring in one Extra Weft—One-and-One Wefting—Two-and-Two Wefting—One-and-Two Wefting—Two-and-Four Wefting—Selection of Suitable Positions for the Figuring Floats—Extra Material Cut Away—Extra Weft Stitched In—Modification of Ground Weave—Intermittent Extra Weft Figuring—Combination of Ground Weft Figure and Extra Weft Figure—Stitching by means of Special Ends—*Figuring with Two or More Colours of Extra Weft*—Pick-and-Pick Figuring—Methods of indicating Pick-and-Pick Ground Weaves — Pick-and-Pick Weave Shading — Pick-and-Pick Reversible Tapestry Style—Multiple Weft Persian Style of Figuring—Chintzing—*Reversible Weft-Face Figured Fabrics* — Simplified Methods of Designing — Treble-Wefted Reversible Fabrics.

PRINCIPLES OF FIGURING WITH "EXTRA" MATERIALS

A DISTINGUISHING feature of fabrics in which extra materials are employed is that the withdrawal of the extra threads from the cloth leaves a complete structure, which is more or less perfect according to the manner in which the ground threads have been interwoven under the figure. This is illustrated in Fig. 110, where the lower portion of the extra warp figured stripe, lettered A, is shown with the extra ends removed, leaving a perfect plain ground texture. The figuring ends in stripe B are not extra, but are simply crammed in the reed, and, as shown in the lower portion of the stripe, their withdrawal completely destroys the cloth structure since only the weft picks remain. The formation of a figure by means of extra threads thus does not detract from the strength or wearing quality of a cloth, except so far as the extra threads are liable to fray out, whereas in ordinary fabrics, in which the figure is formed by floating the weft or warp threads loosely, the strength of the cloth is reduced somewhat in proportion to the ratio of figure and ground.

One of the advantages of figuring with extra materials is that bright colours—in sharp contrast with the ground—may be brought to the surface of the cloth in any desired proportion. Pleasing colour combinations, bright or otherwise, may thus be conveniently obtained, since the extent of surface allotted to the figuring colour may be readily proportioned in accordance with the degree of its contrast with the ground shade, without the latter being affected.

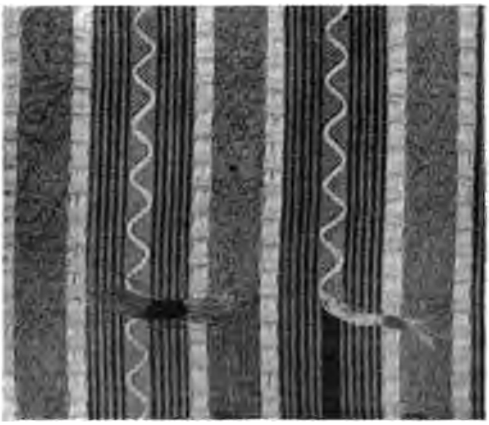


Fig. 110.

Methods of Introducing Extra Figuring Threads.—The extra threads may be introduced either as weft or warp, or the two methods may be employed in combination. They may be inserted in the ordinary manner, or by special means—*e.g.* as weft in the swivel loom, or as warp by means of the lappet mechanism; while after the cloth is woven the embroidery frame is now largely requisitioned for producing the desired pattern. Compared with the ordinary system, the special methods usually give greater fulness to the figure, combined, in most cases, with considerable saving of material.

In the ordinary method of introducing the extra materials the form of the design may render it necessary for the extra threads to be inserted in continuous order with the ground threads, or in intermittent order, while where they are introduced the arrangement of the figuring and ground threads may be 1-and-1, 1-and-2, 1-and-3, etc., according to the structure of the cloth and solidity of figure required. In extra weft figures, for looms with changing boxes at one end only, similar results to the 1-and-1 order may be produced by wefting 2-and-2; while the 2-and-4 order may be substituted for the 1-and-2, with, however, less satisfactory results as regards the solidity of the figure.

Methods of Disposing of the Surplus Extra Threads.—The disposal of the extra warp or weft threads, in the portions of the cloth where they are not required to form figure, is of great importance, and one or other of the following methods may be employed:—

(1) The extra yarn is allowed to float loosely on the back in the ground of the cloth. This method is suitable when the space between the figures is not excessive,

and the ground texture is dense, but it is usually not applicable to cloths in which the ground is so light and transparent that the positions of the extra threads on the back can be perceived from the face side.

(2) The extra yarn is allowed to float loosely on the back, and is afterwards cut away. This method is eminently suitable for light ground textures, but if the extra picks float somewhat loosely on the surface in forming the ornament, it is necessary for them to be bound in at the edges of the figure, or the loose figuring floats will readily fray out from the surface. The firm interweaving of the extra picks at the edges, however, makes the outline of the figure less distinct, and is rather objectionable unless employed in such a manner as to assist in forming the figure.

(3) In compact fabrics the extra threads are bound in on the underside of the cloth, either between corresponding floats in the ground texture, or by means of special stitching threads.

(4) The extra threads are interwoven on the face of the cloth in the ground for the purpose of giving a rich and full appearance to what would otherwise be a bare ground texture.

FIGURING WITH EXTRA WEFT

Extra weft figured fabrics nay be formed with one, two, or more extra wefts; thus, including the ground threads, they consist of two or more series of weft threads and one series of warp threads.

Continuous Figuring in one Extra Weft—One-and-One Wefting.—A simple example is shown in Fig. 111 in which one extra weft is introduced continuously with the ground weft in the order of a pick of each alternately. The face of the cloth is represented on the left of Fig. 111, and the underside on the right. The ground ends and picks interweave in plain order, while the extra picks float loosely on the back where no figure is formed on the surface. The method of designing for the style is very simple, since it is only necessary for the weft figure to be indicated on the paper, as shown in the corresponding design given at C in Fig. 112. The card-cutting particulars are—cut blanks for the extra picks, and cut the ground

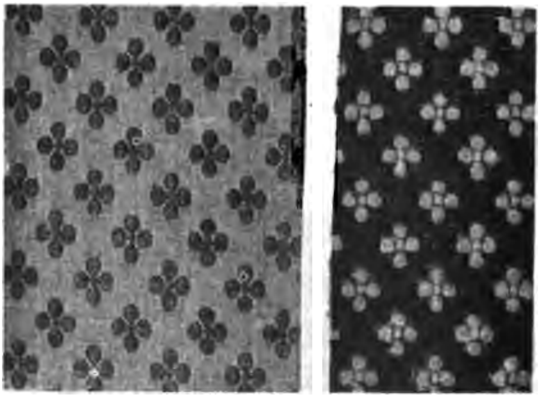
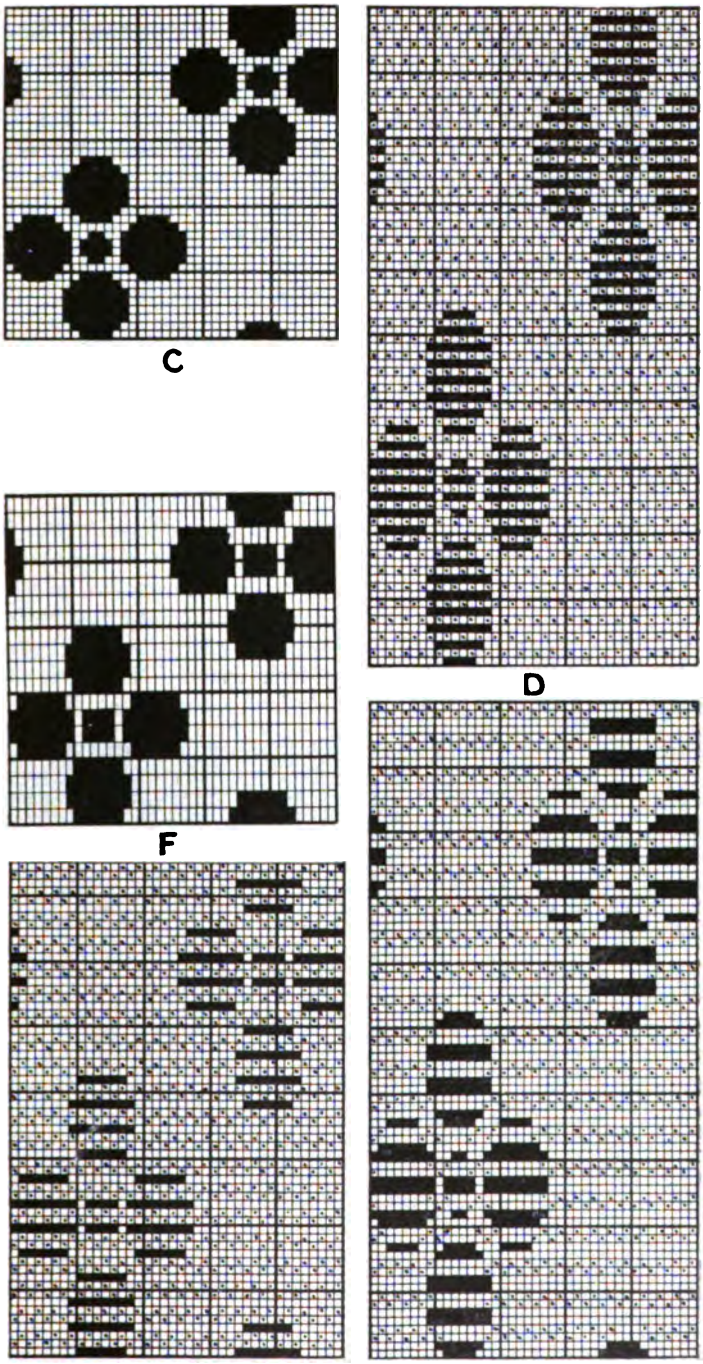


Fig. 111.



C

D

F

G

E

Fig. 112.

(*Note.*—A portion of figure is omitted on the first and third picks of D.)

cards plain; the latter, however, are readily obtained by repeating. The complete structure, given at D in Fig. 112, shows the figuring picks arranged in alternate order with the ground picks, the former being indicated by the full squares and the latter by the dots. A sectional drawing is given at D in Fig. 113, which shows how the picks 2, 3, and 4 of D in Fig. 112 interweave with the ends 1 to 20.

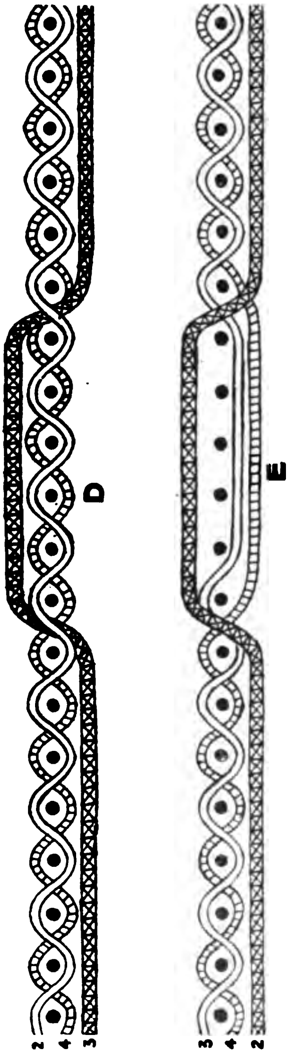


Fig. 113.

Two-and-Two Wefting.—E in Fig. 112 shows the full development of the design C, assuming that it is produced in a loom with changing boxes at one end only, in this case two figuring picks alternating with two ground picks. Unless the figuring weft is heavy there is a tendency, in the 2-and-2 order of wefting, for the extra picks to show in pairs where the figure is formed, this being particularly noticeable if the ground picks interweave firmly underneath. Greater solidity of figure can be obtained by discontinuing the weave of the ground picks, beneath the extra weft floats, in the manner shown in the design E. The warp threads under the figure thus lie between the extra weft floats on the surface, and the ground weft floats on the underside, and no obstacle is offered to the pairs of figuring floats approaching each other. This is illustrated by the sectional drawing given at E in Fig. 113, which shows the interweaving of the picks 2, 3, and 4 of design E with the ends 1 to 20. With this arrangement it is not possible to repeat the ground cards, but they may be cut from the design painted solid, as at C. Each pick on the design paper is cut twice, the card-cutting instructions being—1st card, cut all but the marks; 2nd card, cut the marks, and the ground plain. The cards are then laced together in the order of two figuring cards and two ground cards.

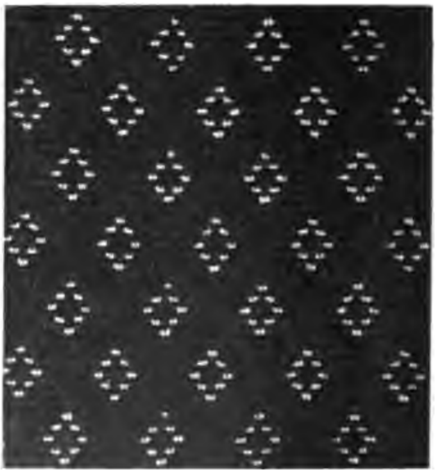
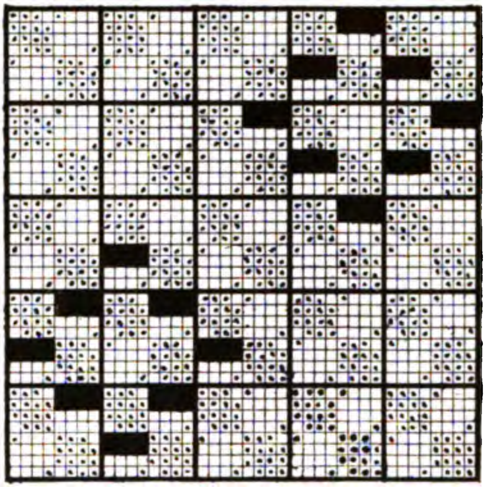


Fig. 114.

Suitable weaving particulars for the fabric represented in Fig. 111 are—2/80's cotton warp, 80 ends per inch; and 40's cotton ground weft with 80 ground picks per inch; while the counts of the extra weft may be varied from the equivalent of 40's to 20's cotton according to the desired prominence of the figure. In designing an extra weft figure solid the counts of the point-paper is decided by the relative number of ends per inch to figuring picks per inch. In the 1-and-1 and 2-and-2 arrangements the number of extra picks and ground picks per inch are the same, therefore the counts of design paper for the design C, with the foregoing particulars, is as 80 ends : 80 picks = 8 × 8.

One-and-Two Wefting. — The 1-and-2 order of introducing the extra weft is more economical than the 1-and-1, but with the same number of ground threads per inch the extra weft requires to be thicker, and the figure should usually be more massive. Assuming that the figure given at C in Fig. 112 is required to be produced in the 1-and-2 order, and that the ground threads per inch are as before, the extra picks per inch will be 40, and the counts of the point-paper as 80 ends : 40 picks = 8 × 4. To correspond with C the solid plan will then be as indicated at F, and the complete structure as shown at G, in Fig. 112.

Two-and-Four Wefting. — In the 2-and-4 order of wefting, a similar appearance could not be given to the figure shown at F in Fig. 112, although the proportion of extra picks to ground picks is the same as in the 1-and-2 order, because the splitting of the figuring picks in pairs would be too pronounced. When the 2-and-4


H

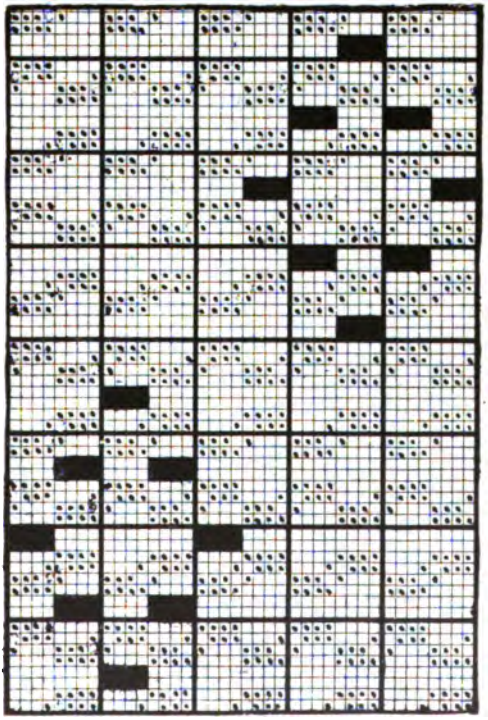

I

Fig. 115.

arrangement is employed it is preferable to adapt the form of the figure to the wefting order, in the manner illustrated by the pattern represented in Fig. 114, which is a spotted vesting style. In the corresponding design given at H in Fig. 115, and the complete structure shown at I, the full squares show where the extra weft floats on the surface, while the dots represent the ground weave, which is a modified hopsack.

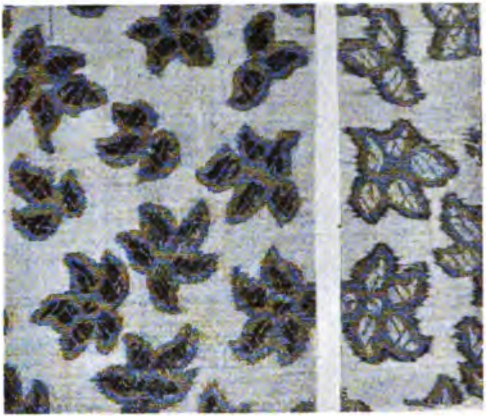


Fig. 116.

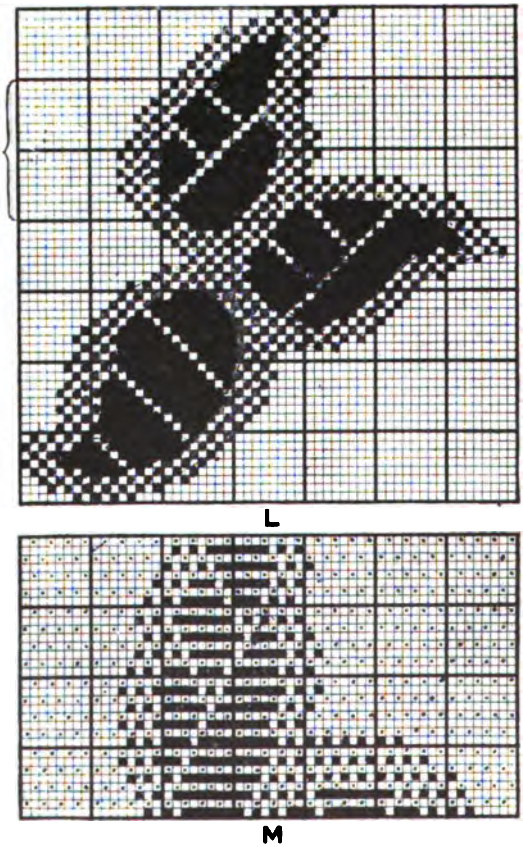


Fig. 117.

Selection of Suitable Positions for the Figuring Floats.—Fig. 115 illustrates an important principle in extra weft spotting—viz., the selection of suitable positions for the figuring floats in relation to the ground weave. It will be noted in the plan I that the extra weft spots are formed in the centre of the warp floats in the ground, so that the best possible conditions are secured for showing the figuring floats prominently on the surface. It is necessary to avoid covering the figuring floats by adjacent ground weft floats (which would have occurred in the example if they had been placed four ends to the right or left) as much as possible.

Extra Material Cut Away.—In the example given in Fig. 116 the figure is formed in extra weft on a plain transparent ground texture, which necessitates that the extra material be cut off on the underside. The face of the cloth is represented on the left and the underside on the right of Fig. 116. In order to avoid the liability of the severed picks fraying out, the extra weft is interwoven in plain order at the sides of the figuring floats, but as this causes the shape of the figure to be modified, the plain interweaving is shown extended completely round so as to produce an opaque outline between the weft figure and the thin ground texture. More plain weave is shown than is really necessary to bind the figuring floats, the idea in this case having been to form distinct shapes upon which to develop the figure.

The plan L in Fig. 117 illustrates the method of indicating the design upon point-paper. The figure is first painted in solid, then weaves are inserted for the purpose of developing it, and to stop long weft floats, after which the plain binding is indicated round the figure. The complete structure of the portion of L indicated between brackets is shown at M in Fig. 117; while N in Fig. 118 shows how the last extra pick of M and the ground pick on each side interweave with the ends 15 to 34.

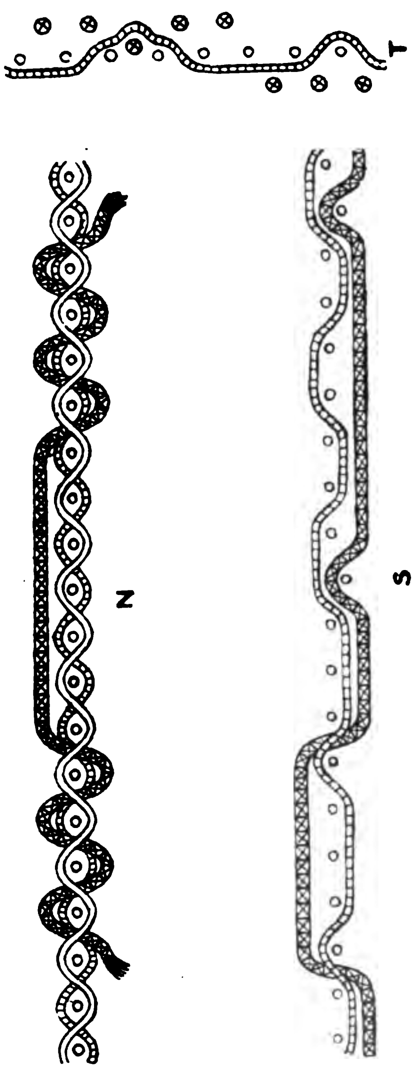


Fig. 118.

Extra Weft Stitched In.—The example given in Fig. 119 and the corresponding plans in Fig. 120 illustrate the principle of stitching in the extra weft on the underside of the cloth in places where it is not required for forming figure. For fabrics in which the additional weight is not objectionable, the method is useful, since the binding in of the extra weft gives greater substance to the cloth. The ground weave is 2-and-2 twill, and the picks are inserted continuously in the order of 1 extra, 1 ground. Q in Fig. 120, which corresponds with a portion of the design, illustrates the system of painting in the figure, and shows how the stitches are indicated; while R represents the complete structure of the bracketed portion of Q. In Fig. 118 a sectional drawing is given at S, which shows how the picks 20 and 21 interweave with the ends 17 to 36 of R; and, similarly, T shows how the twentieth end interweaves with the picks 17 to 32 of R. In the drawings the extra picks are shown larger in diameter than the ground threads.

In arranging the positions of the stitches the system is similar to constructing the backing weave of a weft-backed fabric (see Chapter I)—that is, the end on which a weft stitch is made should be down on the ground picks which precede and succeed the stitch. Thus in R, Fig. 120, each stitching mark is preceded and

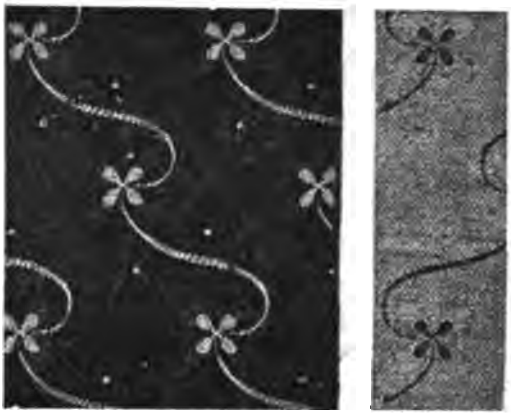


Fig. 119.

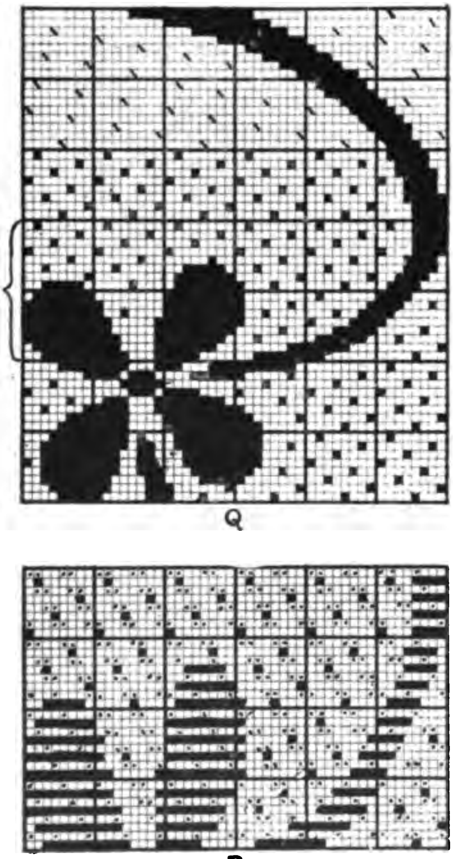


Fig. 120.

followed by a ground weave mark, the effect of the arrangement being clearly shown in the sectional drawings given at S and T in Fig. 118.

Generally the ground weft floats will close together and effectively conceal the binding points, but if the figuring weft is much thicker than the ground weft there is a liability of the stitches forcing the ground picks apart and showing on the surface, particularly if there is a strong colour contrast between the figuring weft and the ground. In such a case the stitches should be as infrequent as possible, in order that the extra picks will hang loosely on the back. For the purpose of illustration, two methods of stitching the 2-and-2 twill are given at Q in Fig. 120. The 16-thread sateen order, shown in the upper portion of the plan is more suitable if the stitches are liable to show on the surface, and the 8-thread sateen order indicated in the lower portion, for giving a firmer and more satisfactory back to the cloth. In a figured fabric the production of a firm back is not so important as in a backed cloth, and as there is usually greater contrast in the colours of the respective weft yarns, a looser order of stitching is generally employed in extra weft-figured cloths than in backed cloths.

Modification of Ground Weave.—The continuation, under the figure, of a ground weave in which the weft passes over two or more ends, is sometimes not satisfactory, because the ground weft floats tend to cover up the figuring floats, and cause the edges of the figure to appear indistinct. In such a case the ground weave should be changed to warp surface under the figure, as shown at R in Fig. 120, in which the 2-and-2 twill is changed to 1-and-3 twill. The warp surface shows up the figure distinctly, but the system makes it necessary for all the ground cards to be cut from the design, whereas they can be repeated when the ground weave is continued under the figure.

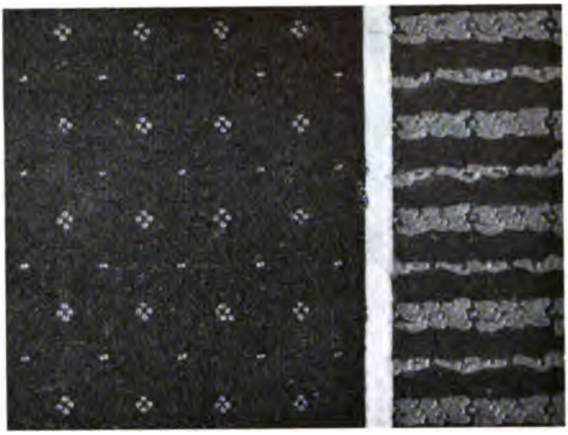


Fig. 121.

Intermittent Extra Weft Figuring.—The fabric represented in Fig. 121 illustrates the principle of introducing the extra weft in intermittent order with the ground weft, for the purpose of producing a detached spot effect. The ground weave is a compound of several weaves arranged in check form, and where the extra weft is introduced it is arranged in 2-and-2 order with the ground weft. The face of the cloth is shown on the left and the underside on the right of Fig. 121. In the corresponding plan given at C in Fig. 122 the shaded marks indicate the ground weave, and the solid black marks between the picks the position of the extra weft figure and the stitches. This method of indicating the design is convenient, since it enables the figure and the stitches to be readily placed in the best possible relation to the ground weave, while any ground weave marks that are liable to detract from the clearness of the spots are easily seen and removed. Also the cards can be cut, or the draft and pegging plan be prepared, directly from the condensed plan. D in Fig. 122 shows the complete structure of the picks 1 to 16 of C, the circles against the extra weft floats indicating ground weave marks, which may, with advantage, be taken out. (A spotted gauze effect is shown in Fig. 262.)

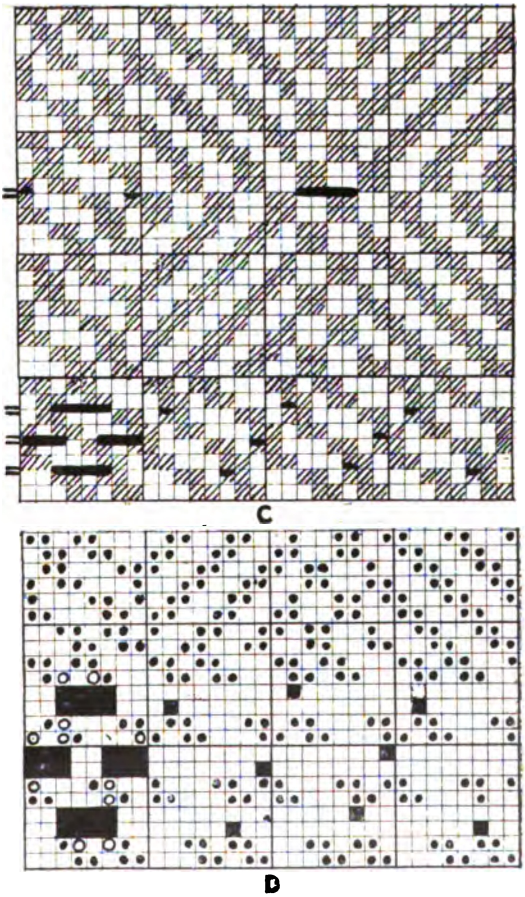


Fig. 122.

Compared with a continuous order of introducing the extra weft, an intermittent order is economical, both as regards the productiveness of the loom and the quantity of extra material which is required. The weaving of the cloth, however, is more complicated, since the boxing and take-up motions require to be regulated in accordance with the irregular order of wefting; while if odd picks of extra weft are introduced the picking is also more complex. The best arrangement consists of manipulating the boxing, picking, and take-up motions from the shedding mechanism, with which they are thus kept in unison.

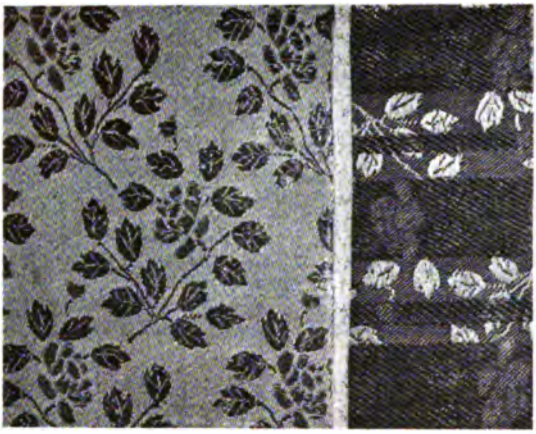


Fig. 123.

Combination of Ground Weft Figure and Extra Weft Figure. — Fig. 123 shows the face and back of a cloth in which an intermittent extra weft figure is combined with a figure formed by the ground weft; while the sectional design, given in the upper portion of Fig. 124, shows the most convenient method of indicating such a style on point-paper. All the figure is painted in solid, the ground weft figure in one colour (represented by the full. squares), and the extra weft figure in a second colour (represented by the crosses). The 5-thread warp sateen ground weave is then indicated in the same colour as the ground figure, except where a third colour is employed (represented by the dots) to show where the extra weft is stitched in on the back. White may be used for stopping the floats of the figure.

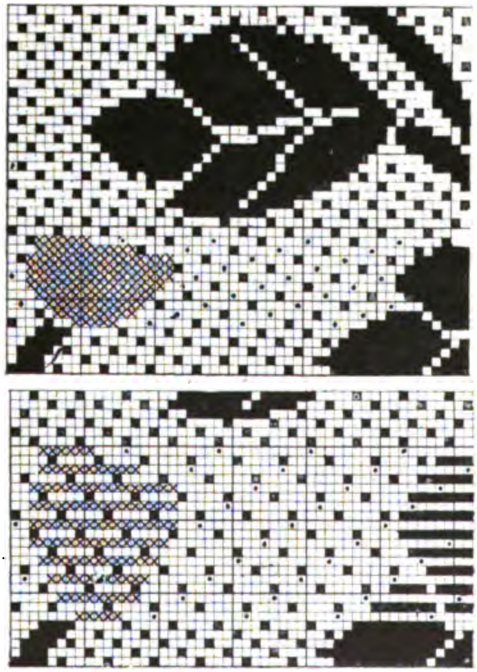


Fig. 124.

From each horizontal line where the extra weft is indicated, two cards are cut as follows:—(1) For the extra pick, cut all but the crosses and the dots, and continue the binding weave under the ground weft figure. (2) For the ground pick, cut all but the full squares and the dots, and continue the 4-and-1 ground weave under the extra weft figure. The complete structure is then as shown in the sectional plan in the lower portion of Fig. 124, where the picks 1 to 20 of the solid plan are represented in full.

Stitching by means of Special Ends.—The method of binding in the extra weft on the underside by means of a special stitching warp is illustrated by the fabric represented in Fig. 125, and the corresponding examples given in Fig. 126. The ground of the cloth is 2-and-2 twill, and the following are the weaving particulars :—

Warp : 2/56's green botany worsted. 72 ends per inch.
Weft : 1 pick 30's green botany worsted (ground).
1 pick 12's soft spun brown worsted (figuring).
64 ground picks and 64 extra picks per inch.

In this case the purpose of binding in the extra material where no figure is formed is to give substance and softness of handle to the cloth. There is such a great difference, however, in colour and thickness between the figuring and ground wefts, that in the ordinary method of binding (illustrated in Fig. 120) the stitches would be very liable to force the finer ground picks apart and show on the surface. The binding is therefore effected by the warp, every ninth thread of which is employed as an extra thread for the purpose, as shown in the sectional plan given at A in Fig. 126. In the plan the crosses indicate where the binding ends are left down ; the diagonal marks where the ground weft passes over the ground warp in 2-and-2 twill order ; and the full squares where the figuring weft is on the surface. The binding ends are down on all the figuring picks, and are raised alternately on every fourth ground pick. B in Fig. 126 represents the interlacing of the second ground pick and the second figuring pick of A. In the ground portions of the fabric the figuring weft lies between the extra warp threads and the ground texture. The interweaving of the stitching warp with the ground picks is invisible on the surface of the cloth because it is of the same thickness and shade as the ground warp, and at each binding place it lies between two ground-warp floats.

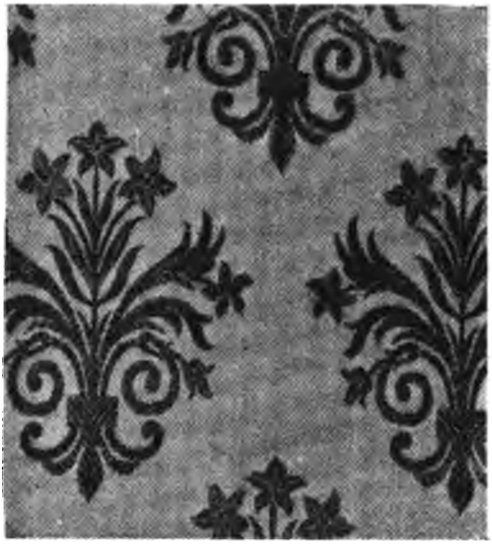


Fig. 125.

C in Fig. 126 shows the method of designing the figure on point-paper. As the extra threads, which are used for binding, interweave in exactly the same order throughout, they can be operated by two healds placed in front or behind the harness. The cards for the ground picks can be obtained by repeating; hence, in working out the design on point-paper it is only necessary to consider the interweaving of the figuring picks with the ends which are drawn through the harness. The figure is therefore painted in solid, and the long weft floats are stopped by inserting suitable weaves, as shown. The card-cutting particulars are: Cut all but the weft figure.

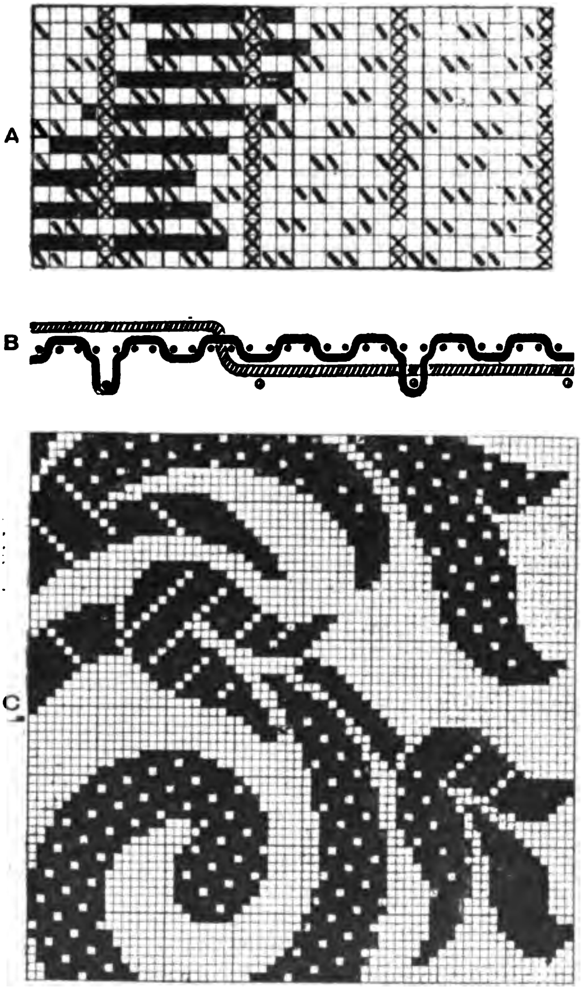


Fig. 126.

Figuring with Two or more Colours of Extra Weft.---When a figure is required in two or more colours of extra weft, it is most economical to so arrange the design that there are never more than one colour employed for figuring in the same horizontal line of the fabric. The type is illustrated in Fig. 127, which shows the face and back of a cloth in which an intermittent figure is developed in gold and white extra wefts; the portion formed by the white weft commencing immediately that formed by the gold weft is completed. Only the same weight of extra material is thus required as for a figure of the same size in one colour of extra, but the boxing plan is rather more complex.

A in Fig. 128 illustrates the principle of indicating such a figure on design paper, the full squares representing one extra colour and the crosses the other, while the dots show additional figure formed by the ground weft. B shows the complete structure of a portion of A, with the extra weft stitched between the ground weft figuring floats. The order of wefting is as follows :—

4 picks ground.
1 pick first extra. } 10 times.
1 „ ground.
1 „ second extra. } 6 times.
1 „ ground
8 picks ground.

Continuous Figuring with Two Extra Wefts.—Fig. 129 represents the face and back of a cloth in which a continuous figure is developed in two colours of extra weft, a pick of each being introduced regularly with each pick of the ground weft. Assuming that the number of ground picks per inch is the same as the number of ground ends, the figure may be painted solid in two colours on 8 × 8 design paper, as indicated at A in Fig. 130. The full squares represent one colour of extra, and the crosses the other colour, each horizontal space on the paper being equivalent to three picks, of which one is a ground pick. B in Fig. 130, shows a portion of the complete structure which results from cutting each horizontal space of A as follows:—First card, cut all but the full squares; second card, cut all but the crosses; third card, cut plain. C shows the corresponding structure, assuming that the wefting order is arranged 2-and-2 to fit a loom with changing boxes at one end only.

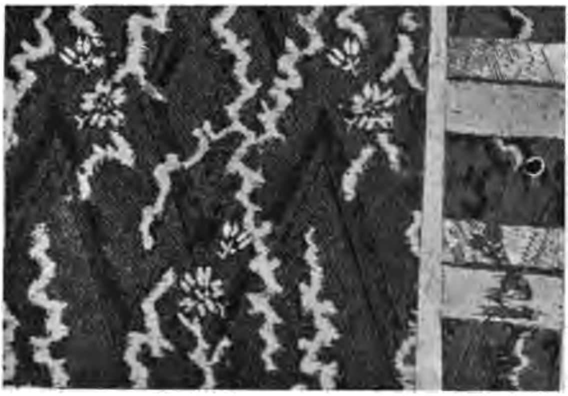


Fig. 127.

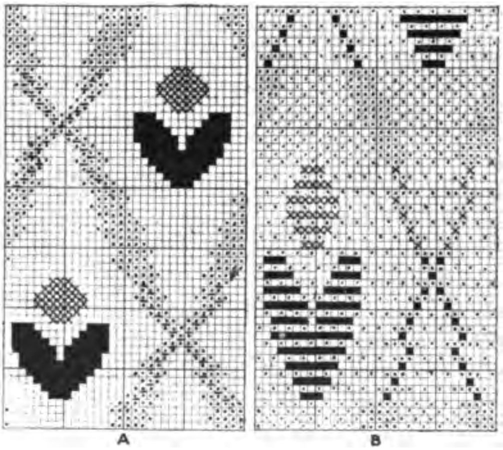


Fig. 128.

A more productive and economical method of introducing the two extras continuously consists of doubling each extra, and wefting in the order of 1 double-pick—first extra; 1 ground; 1 double-pick—second extra; 1 ground; as shown at D in Fig. 130. The figure, however, is not so solid, and it is necessary to note that with an equal number of ground ends and picks per inch, 8 by 4 paper will be required in painting the design solid, since there are two ground picks to each double pick of each colour.

Pick-and-Pick Figuring.—A class of extra weft fabric is used for trimmings, and for tapestry and upholstery purposes, etc., in which no separate ground weft is employed in forming the foundation. All the wefts are floated on the surface as required in producing the figure, but each also assists in making the ground structure. Fig. 131 represents a cloth in which the figure is formed in two colours of weft—woven pick-and-pick—upon a sateen foundation, which is produced by the two wefts interweaving with the warp. The following are suitable weaving particulars for a tapestry cloth:—Warp, 60/2 spun silk, 180 ends per inch. Weft, 50/2 spun silk, 180 picks per inch.

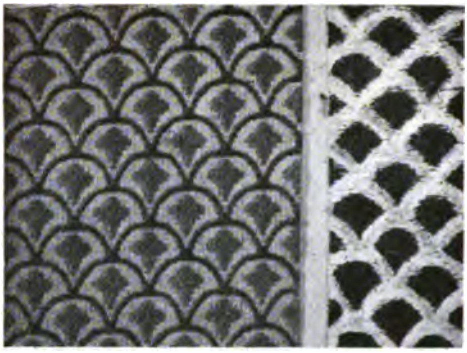


Fig. 129.

A in Fig. 132, which corresponds with a portion of Fig. 131, illustrates the system of constructing the point-paper design. The figure is painted in solid in two colours to represent the different wefts, and the ground is indicated in a third colour; while it is convenient to use white in binding the floats of the figure. Each horizontal space corresponds to a pick of each colour, and the counts of the design paper is therefore in the proportion of the number of ends per inch to the number of picks per inch of each colour, or 8 × 4 with the foregoing particulars. Two cards are cut from each horizontal space, as follows :—

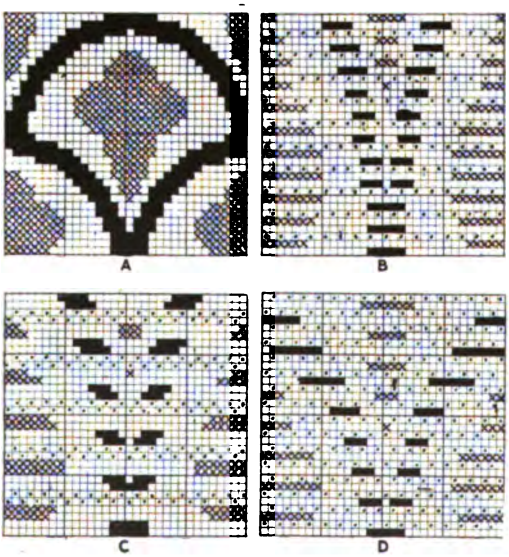


Fig. 130.

First card : Miss the marks of the first colour and the ground marks, and cut the marks of the second colour plain.

Second card : Miss the marks of the second colour and the ground marks, and cut the marks of the first colour plain.

The effect of the cutting is illustrated at B in Fig. 132, which shows the full weave of the picks 1 to 12 of A. It will be seen that the ground weave is 8-sateen—two picks in a shed, while where one weft is floated on the surface, the other weft forms plain weave underneath. The warp threads are usually so finely set in these cloths that the weft intersections in the ground have scarcely any effect upon the solidity of the warp colour.

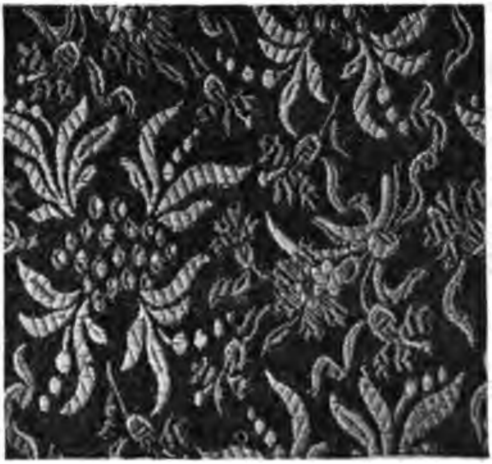


Fig. 131.

If it is necessary to insert the weft colours in 2-and-2 order, on account of the loom being provided with changing boxes at one end only, the system of cutting the design given at A in Fig. 132 will be the same as before but in the following order :

Odd horizontal spaces—
  First card : cut for the first colour.
  Second card : cut for the second colour.
Even horizontal spaces—
  First card : cut for the second colour.
  Second card : cut for the first colour.

The cards are arranged to coincide with the 2-and-2 order of wefting, and the 8-sateen ground weave then produces the structure shown at C in Fig. 133, in which the weft intersections are two in a shed.

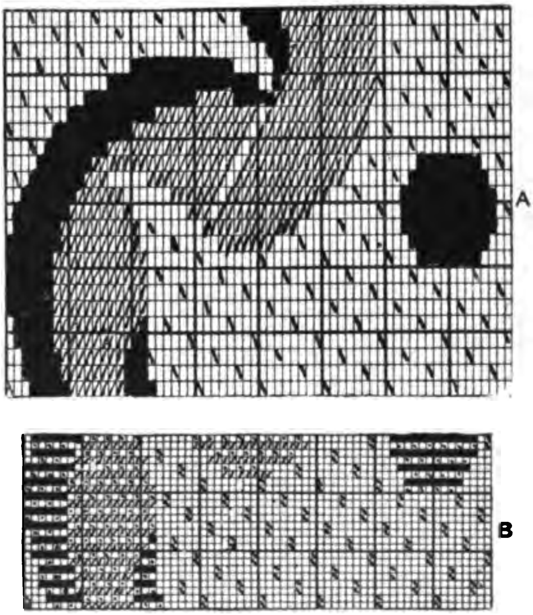


Fig. 132.

Methods of Indicating Pick-and-Pick Ground Weaves. — A number of ground weaves, which are used in the pick-and-pick system of figuring, are given at D to L in Fig. 133. A fine warp-rib ground is formed by employing plain ground weave, as shown at D, the cutting of two cards from each space producing a 2-and-2 warp-rib structure, as indicated at E.

The ground weave given at F is based upon 5-sateen weave, but two colours are represented by the solid marks and crosses, each of which is in 10-sateen order. The idea in this case is to interweave one weft more firmly than the other, which is effected by cutting the ground weave as follows :—

First card : Miss only the full squares.
Second card : Miss both marks.

The complete ground weave is shown at G in Fig. 133, in which it will be seen that the odd picks float in 9-and-1 order on the back, and the even picks in 4-and-1 order. The longer float of the odd picks causes them to stand out behind the even picks on the underside of the cloth, and as they interweave with the warp in the same shed as the even picks they are prevented by the latter from showing on the surface. The method enables a weft which is thicker, or in stronger colour contrast with the warp than the other, to be thrown chiefly to the back in the ground, so that the solidity of the warp colour is affected as little as possible. Other sateens can be arranged in the same manner as the 5-sateen.

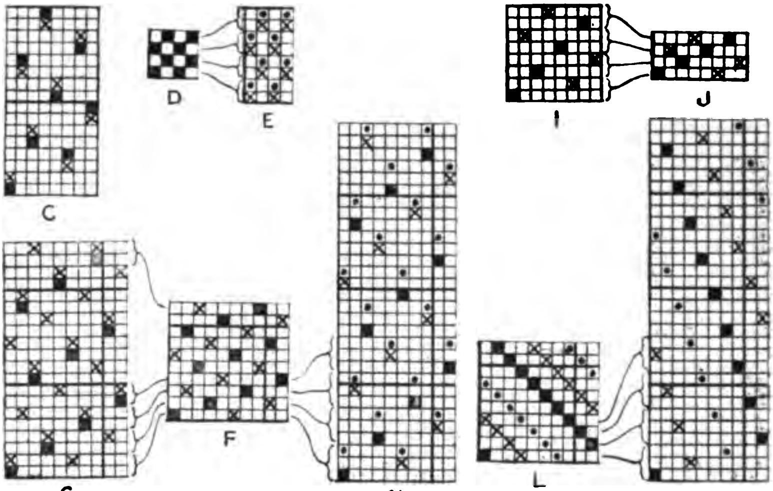


Fig. 133.

If three colours of weft are employed—a pick of each alternately—the system of marking, shown at F in Fig. 133, will enable two of the wefts to be thrown more to the back than the third, by cutting as follows:—

First card: Miss only the full squares.
Second card: Miss only the crosses.
Third card: Miss both marks.

The corresponding complete weave is given at H.

The preceding system of indicating and cutting sateen-ground weaves is liable to produce warp floats that are too long when the cloth contains only a comparatively few picks per inch. In such a case firmness can be obtained by changing the weft intersections on succeeding picks, as in the ordinary method of weaving sateens. The ground weave is then indicated on the solid plan in such a manner that two or more picks of the sateen weave can be cut from each horizontal space. The method will be understood by comparing I with J in Fig. 133; I shows the ordinary 8-sateen weave formed by two wefts, while each horizontal space of J includes the marks upon two consecutive picks of I. In the same manner K shows the full 10-sateen weave formed by three wefts while each horizontal space of L includes the marks upon three picks of K. The card cutting particulars which will form the 10-sateen ground weave in three wefts from the marking indicated at L, are as follows:—

First card: Miss the solid marks.
Second card: Miss the crosses.
Third card: Miss the dots.

However many wefts are employed in forming a design, the figure is painted in solid in different colours to represent the separate effects, as shown at A in Fig. 132, and as many cards are cut from each horizontal space as there are figuring colours indicated upon it. Suitable weaves are inserted on the figure to develop it and to stop long weft floats. For the purpose of illustration, the method of designing a three-colour effect is shown at M in Fig. 134, while N represents how the threads are interwoven by cutting three cards from each horizontal space of M as follows:—

First colour: Miss the solid marks (figure) and the circles in the ground, and continue the ground weave where the other colours form figure.

Second colour: Miss the crosses (figure), and the circles and crosses in the ground, and cut the first and third figuring colours plain.

Third colour: Miss the dots in both figure and ground, cut the second figuring colour plain (the crosses), and continue the ground weave where the first colour forms figure (the full squares).

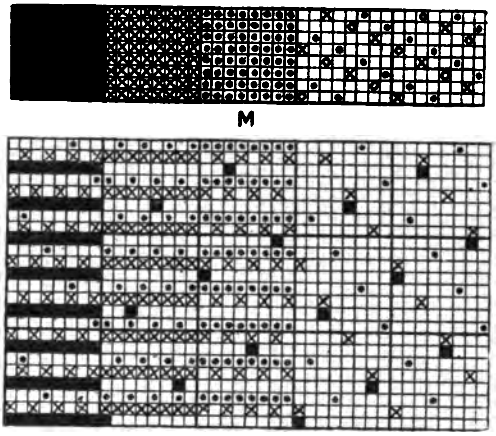


Fig. 134.

From an examination of N it will be seen that the first figuring colour floats in 15-and-1 order on the underside, except where it forms figure, while the third figuring colour floats in 7-and-1 order in the ground and under the figure formed by the first colour. Plain weave is formed by the second colour under the figure formed by the first and third colours, and by the third colour under the figure formed by the second colour. In the ground 8-sateen weave is formed by the second and third colours together, and the first colour is stitched on alternate ends in the same shed as the second colour. (The method of designing for multiple-weft figured fabrics in a split harness mount is illustrated at E, F, and G in Fig. 189).

Pick-and-Pick Weave Shading.—A fabric is represented in Fig. 135 in which different degrees of light and shade are formed by means of weave shading, in a pick-and-pick order of wefting. The warp is white, while the weft is arranged 1 pick green, and 1 pick white. Similar weaves to those employed in the cloth are given in full in Fig. 136, in which the solid marks represent the green weft floats, and the dots the white weft floats. A portion of white weft figure, under which the green weft interweaves in plain order, is produced by section A. In section B a white surface is formed by the white weft interweaving in plain order with the white warp, the green weft floating on the back in 7-and-1 order. Section C is in slight colour contrast to section B, as the green weft interweaves in plain order with the white warp, so that a mixed green and white surface is formed, under which the white weft floats in 7-and-1 order. In section D, above a plain white foundation formed by the interweaving of the white weft with the white warp, the green weft is passed in gradually increasing lengths of float, so that the white surface gradually merges into a green surface. Section E shows the weave which is used in forming a solid white ground, the white warp interweaving in 8-sateen order with the white weft, and in 16-sateen order with the green weft. As in the previous examples, the design can be painted in such a manner that two cards—one for each colour of weft—may be cut from each horizontal space.

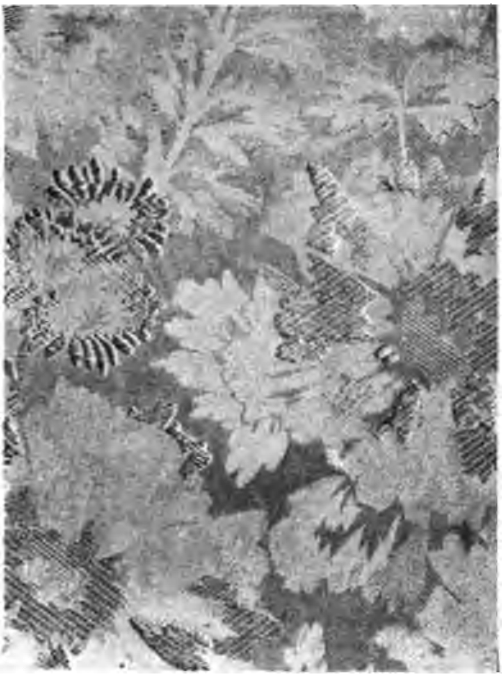


Fig. 135.

Pick and Pick Reversible Tapestry Style.—A perfectly reversible fabric, which is figured in two colours of weft arranged in pick-and-pick order, is represented as viewed from opposite sides, in Fig. 137. Where one weft forms figure on one side, the other weft forms a similar figure on the other side; also the ground weave (a warp rib) is the same on both sides. The style of structure is particularly suitable for use as a hanging fabric.

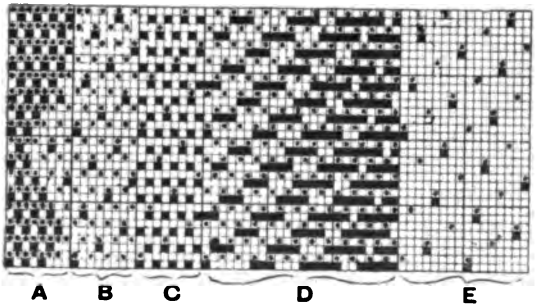


Fig. 136.

A portion of the design is given in the upper portion of Fig. 138, in which three different kinds of marks are indicated; one for each weft where figure is formed, and the third for the ground weave. The figure is painted to fit with plain ground, and a few threads of plain weave are inserted all round. Then, in order that the floats on the underside will be exactly the same as on the surface, a ground weave mark is inserted on the right-hand edge of each float of figure. Two cards are cut from each horizontal space of the design, as follows:—First card, cut blanks and crosses; second card, cut blanks and solid squares. The complete structure is then as shown in the sectional plan given in the lower portion of Fig. 138, in which it will be noted that the plain weave at the edges of the figure in the solid design produces 2-and-2 warp rib, while the 2-and-2 warp-rib ground is changed to 4-and-4 warp rib. A similar reversible figure, upon the 2-and-2 rib ground shown at E in Fig. 133, can be produced without the ground weave being indicated by simply painting the figure solid in two colours, but the plain edge of one colour requires to be opposite to that of the other colour. The ground is cut plain in reverse order on the two cards that are cut from each horizontal space.

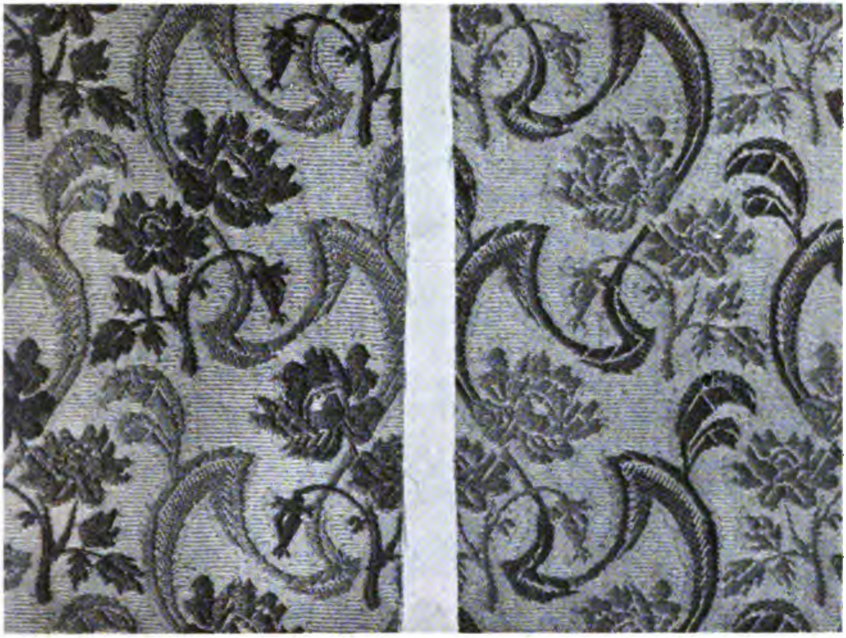


Fig. 137.

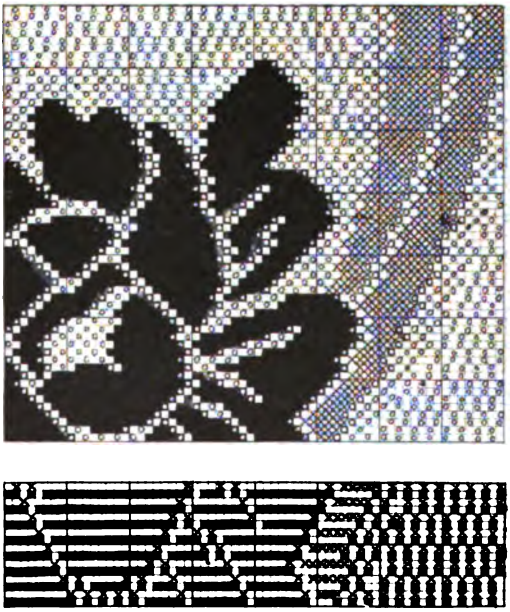


Fig. 138.

Multiple Weft Persian Style of Figuring. — Fig. 139 illustrates a Persian style of texture in which a figure is produced in three colours of weft, while a fourth colour is formed in the ground by the warp. The following are suitable weaving particulars :—

Warp.

All 2/80's dark green cotton. 100 threads per inch.

Weft.

1 pick 30's soft spun white cotton.
1 pick 30's soft spun gold cotton.
1 pick 30's soft spun brown cotton. 150 picks per inch.

The surface of the cloth is almost entirely covered by the figuring floats of the three wefts, and a feature of the example is that the weft floats are not bound in by the warp on the back of the cloth, except in odd places where one of the wefts is used to stop long warp floats in the ground.

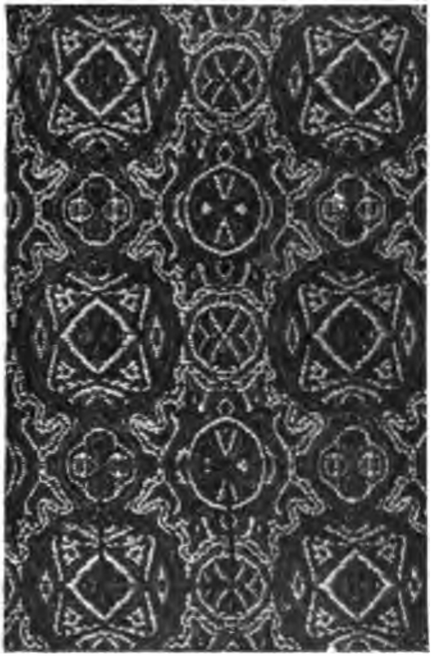


Fig. 139.

The method of drafting the style is illustrated in Fig. 140, in which it will be seen that the design is arranged in such a manner that each weft changes from one side of the cloth to the other very frequently, so that long floats on the back are avoided. Three cards are cut from each horizontal space of the design, as follows :—

First card (white weft) : cut all but the full squares.
Second card (gold weft) : cut all but the dots.
Third card (brown weft) : cut all but the diagonal strokes.

Chintzing. — In all the preceding styles of extra weft figuring more colours of weft can be introduced than there are series of extra threads employed, by "chintzing"—that is, by replacing one colour with another in succeeding horizontal sections of a design. The manner in which the different colours are required to be brought to the surface in forming the design determines the order of wefting, and for economical reasons as few colours as possible should be employed in each horizontal line. The figuring wefts may be inserted in very diverse orders—*e.g.*, a regular order of wefting may be employed, but with all the wefts chintzed ; or one weft may form figure regularly, while another, which is inserted either continuously or intermittently, is chintzed. Examples of chintzed effects are given in Figs. 309 and 313.

Reversible Weft-Face Figured Fabrics.—These cloths are chiefly used for shawls, wraps, dressing-gowns, and rugs, a considerable trade being done in the last type of cloth with the natives of Africa and other countries. The weave is the same in every part of the cloth, and a weft surface is produced on both sides. The design is due to the manner in which differently-coloured wefts are interchanged from one side to the other, a dark figure on a light ground on one side corresponding with a light figure on a dark ground on the other side. This is illustrated by the fabric represented in Fig. 141, in which the reverse side of the cloth is shown in the bottom left-hand corner. A portion of the corresponding design is given in Fig. 142. Generally, the wefts should be brought about equally to the surface on both sides

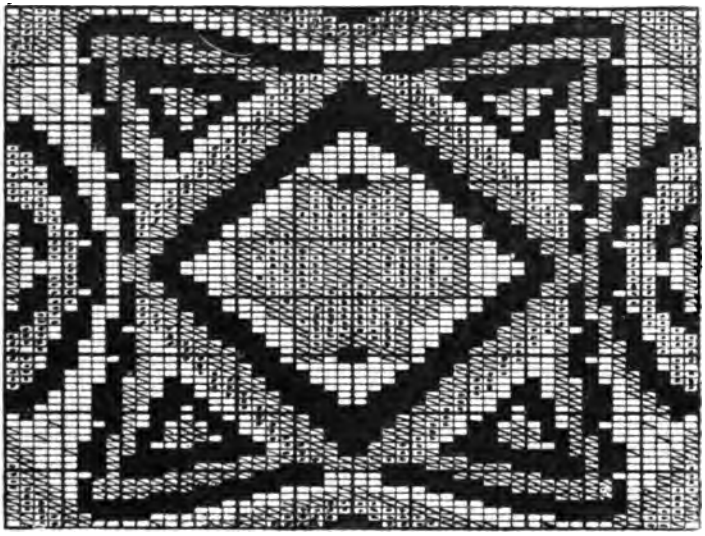


Fig. 140.

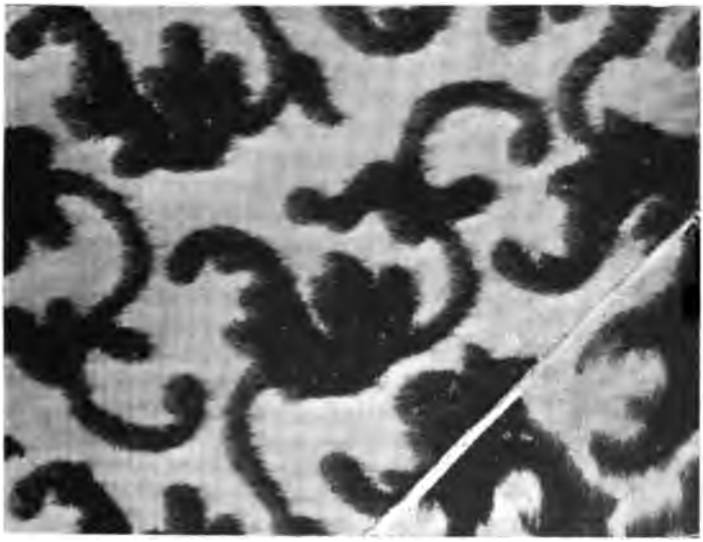


Fig. 141.

in order that one side will not appear darker than the other, this being particularly the case when the cloth is seen on both sides at the same time. A raised finish is applied alike to both the back and face, and when woollen weft is used the shrinkage in width ranges from 15 to 30 per cent. The warp is almost invariably cotton, and suitable weaving particulars for a heavy double-weft fabric in a 4-thread weave are :—2/20's cotton warp, 24 ends per inch, and 96 yards per ounce woollen weft, 48 picks per inch ; and for a lighter cloth : 2/30's cotton warp, 36 ends per inch, and 16 yards per dram woollen weft, 72 picks per inch. The felted and raised finish causes the cotton ends to be entirely concealed, and gives a full soft feel to the cloth. Cheap cloths are made entirely of cotton, the flannelette class of weft being used, which is generally inserted in even picks, and the following weaving particulars are suitable :—

Warp, 16's cotton, 48 ends per inch.
Weft, 12's cotton (soft spun), 84 picks per inch.

The weaves for the figure and ground are constructed upon the same principle as the weft-backed designs illustrated in Figs. 6 and 7 (p. 7), and as shown in Fig. 143, in which the most commonly used reversible plans are given. Both A and B in Fig. 143, in which the marks indicate weft, show the double-face 3-and-1 weft twill weave, but in A the odd picks are on the surface and the even picks on the back; whereas, in B the odd picks are on the back and the even picks on the surface. If, therefore, the picks are arranged 1 dark, 1 light, weave A will produce a dark surface and a light back, and weave B a light surface and a dark back. By combining the two weaves in sections the wefts interchange between the face and back, and a design in two colours is formed, as represented in the diagram C in Fig. 143, which shows the interlacing of the picks 1 and 2 of A and B in combination.

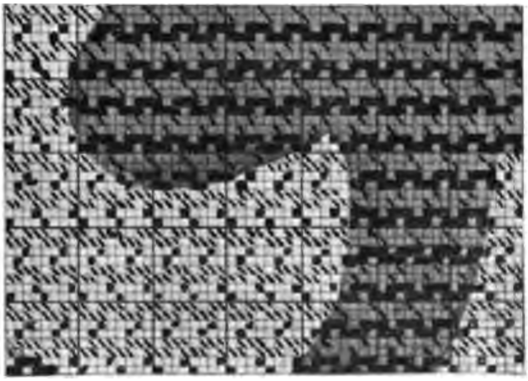


Fig. 142.

D and E in Fig. 143 show the 4-thread, and F and G the 5-thread weft sateens made double face in the same manner as A and B, while H and I illustrate the construction of the double-face 4-sateen weave to fit with a 2-and-2 order of wefting. Other weft-face twill and sateen weaves can be similarly arranged, but, as a rule, a sateen produces a smoother surface, and is therefore more suitable for the raised finish than a twill weave upon the same number of threads. As in weft-backed cloths the chief point to note in each weave of a pair, is that the intersections of the back picks occur between face-weft floats.

Fig. 142, which corresponds with a portion of Fig. 141, illustrates the method of painting out a design in full. The double-face 4-thread weft sateen weaves are combined, and the order of wefting is 2 dark, 2 light. The figure is indicated lightly in a wash of colour, then, in order to produce a dark figure upon a light ground, the weave H in Fig. 143 is indicated in the figured portions, and the weave I in the ground. As the design shows the complete interlacing of the threads, one card is cut from each horizontal space, and the cutting particulars are: Cut all but the weave marks.

Simplified Methods of Designing.—It is a tedious process to paint out a design in full, and in most cases a method can be employed which enables a card for each colour of weft to be cut from each horizontal space, the designing of a figure being then much simpler. For instance, in combining the weaves given at A and B in Fig. 143, the method illustrated in the upper portion in Fig. 144 can be adopted. The figure is indicated by a wash of colour, and 1-and-3 twill is inserted upon both the figure and the ground; or design paper with the 1-and-3 twill printed upon it is used, in which case the twill marking is not required. Two cards are then cut from each horizontal space as follows:—

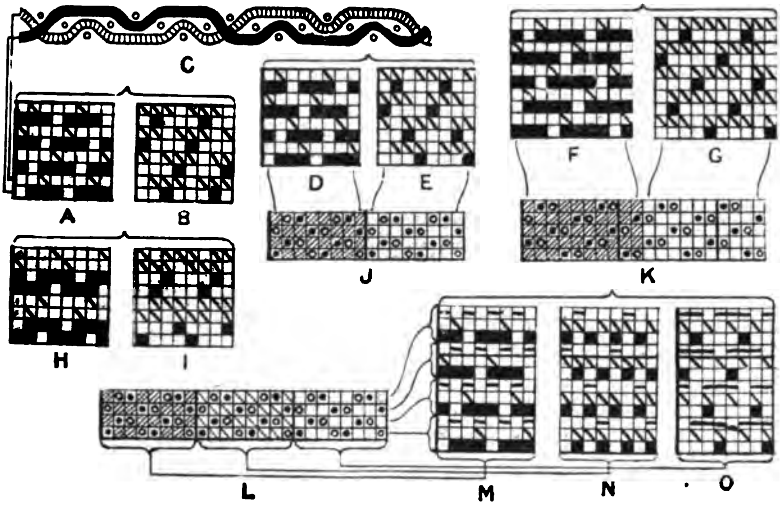


Fig. 143.

On odd horizontal spaces—First card, cut the marks in the figure, and the marks and even threads in the ground; second card, cut the marks and even threads in the figure, and the marks in the ground.

On even horizontal spaces—First card, cut the marks in the figure, and the marks and odd threads in the ground; second card, cut the marks and odd threads in the figure, and the marks in the ground.

The result is the same as if the weaves A and B had been indicated in full, as will be seen from an examination of the lower portion of Fig. 144, which shows the complete structure of the first four horizontal spaces of the solid design. In painting a design in full the design paper requires to be ruled in the proportion of the ends per inch to the total picks per inch, and in the simplified method in the proportion of the ends to the picks of each colour per inch. In the heavily-shrunk cloths it is particularly necessary to use design paper which is ruled in the same proportion as the ends are to the picks in the finished cloth.

J in Fig. 143 shows a method of indicating the figure and ground which enables the weaves D and E to be combined by cutting two cards from each horizontal space, while K similarly represents the combination of the weaves F and G. In both cases each horizontal space is cut twice as follows :—

First card : Cut dots only in the figure, and miss circles only in the ground.
Second card ; Miss circles only in the figure, and cut dots only in the ground.

In the double-wefted cloths only two colours can be brought to the surface in each horizontal line, but more than two colours can be obtained by chintzing. In a pick-and-pick order of wefting, however, a third effect can be formed by combining two weaves such as D and E in Fig. 143 with a third weave, such as H or I, while in a 2-and-2 order of wefting, two weaves, such as H and I, can be combined with a third weave, such as D or E. In each case two of the weaves produce solid effects, whereas in the third the weft colours are intermingled and a subsidiary pattern is formed which can be used to give variety to a design.

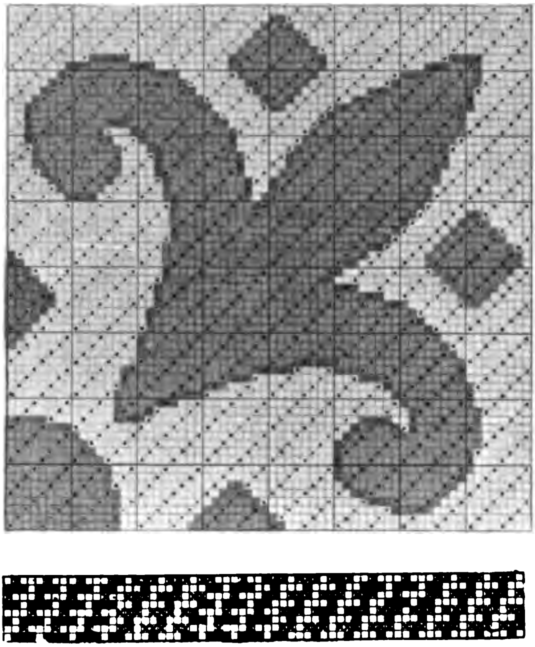


Fig. 144.

In certain low qualities of the woollen-weft cloths the structure is strengthened by the insertion of extra cotton picks at intervals which interweave in plain order with the warp threads. The arrangement may be 4 picks of wool to 1 pick of cotton, or 10 to 2, 12 to 2, etc., plain cards being laced with the figuring cards in the required order. The appearance of the cloth is not altered, but the presence of the cotton picks prevents any tendency of the woollen picks to slip. The production of a loom is, of course, reduced by the insertion of the extra cotton picks.

Treble-Wefted Reversible Fabrics.—The structures are made to a limited extent with three figuring wefts, which enables an effect to be woven in three colours ; while increased weight can be obtained combined with greater firmness, as in the centre the threads may be interwoven more frequently than on the face and back. A figure in two colours on a ground in the third colour may be formed on both sides of the cloth, or one of the wefts may be used to form a solid colour effect on one side of the cloth, while the other two wefts interchange so as to form a figure on the other side.

The plan L in Fig. 143 illustrates a method of indicating a treble-wefted design, arranged a pick of each alternately, in which each weft interweaves on the face, in the centre, and on the back so as to produce a figure in two colours upon a ground in the other colour, on both sides of the cloth. The weave on the face and back is 4-sateen, and in the centre plain. Three cards are cut from each horizontal space of the plan L, as follows :—

First card : Cut the dots in the first figuring colour ; cut the second figuring colour plain ; and cut all but the circles in the ground.

Second card : Cut all but the circles in the first figuring colour ; cut the dots in the second figuring colour ; and cut the ground plain.

Third card : Cut the first figuring colour plain ; cut all but the circles in the second figuring colour ; and cut the dots in the ground.

The complete weaves to correspond are shown separately at M, N and O in Fig. 143 in which it will be seen that in M the first weft floats 3-and-1 on the face, the second weft floats 3-and-1 on the back, and the third weft weaves plain in the centre. In N the first weft weaves plain in the centre, the second weft floats 3-and-1 on the face, and the third weft floats 3-and-1 on the back. In O, the first weft floats 3-and-1 on the back, the second weft interweaves plain in the centre, while the third weft floats 3 and-1 on the face. A figure formed by the first and second wefts on the face is similarly formed by the second and third wefts respectively on the back, while the third weft forms the ground on the face and the first weft the ground on the back. The plain centre weave gives the cloth great firmness, and may be too firm for a heavily-wefted cloth, and in such a case another weave may be used, such as 2-and-2 twill, or 2-and-2 weft rib. The floats in the centre require to be shorter than those on the face and back in order that they will be invisible on both sides.

CHAPTER VI

EXTRA WARP FIGURING

Comparison with Extra Weft Figuring—Continuous Figuring in one Extra Warp—Heald and Harness Mounting—Alhambra Quilts—Binding in Extra Ends between Face Floats—Intermittent Figuring in One Extra Warp—Drafting and Denting Extra Warp Stripes—Figuring with Two Extra Warps—Stitching by means of Special Picks—Extra Warp Planting—End-and-End Figuring—Reversible Warp-Face Figured Fabrics.

Comparison with Extra Weft Figuring.—In extra warp figuring there are two or more series of warp threads to one series of weft threads, and the method has the following advantages and disadvantages, as compared with the extra weft principle :—

Advantages : (1) The productiveness of a loom is greater because only one series of picks is inserted, and a quicker running loom can be used. (2) No special picking, box, and uptake motions are required. (3) There is practically no limit to the number of colours that can be introduced. (4) In an intermittent arrangement of the extra ends either spotted or stripe patterns can be formed, whereas a similar arrangement in the weft can only be used to form spots (except in special cases) because of the objectionable appearance of horizontal lines.

Disadvantages : (1) Two or more warp beams may be required instead of one. (2) If an ordinary jacquard and harness are employed the point-paper designing is more difficult; and a less width of repeat is produced by a given size of machine, because the sett of the harness requires to be increased in proportion to the number of extra ends that are introduced in a design. (3) In dobby weaving the drafts are usually more complicated. (4) Stronger yarn is required for the figure, and the threads are not so soft, full, and lustrous; extra ends are subjected to greater tension during weaving than extra picks, and, as a rule, there is less contraction in length than in width, and the result is that extra warp effects usually show less prominently than extra weft figures. (5) If the extra threads have to be removed from the underside of the cloth, it is more difficult and costly to cut away extra ends than extra picks. The chief advantage of the warp method is in productiveness, but in order that elaborate designs may be designed and woven conveniently and economically, a more complicated jacquard mount is required than in extra weft figuring.

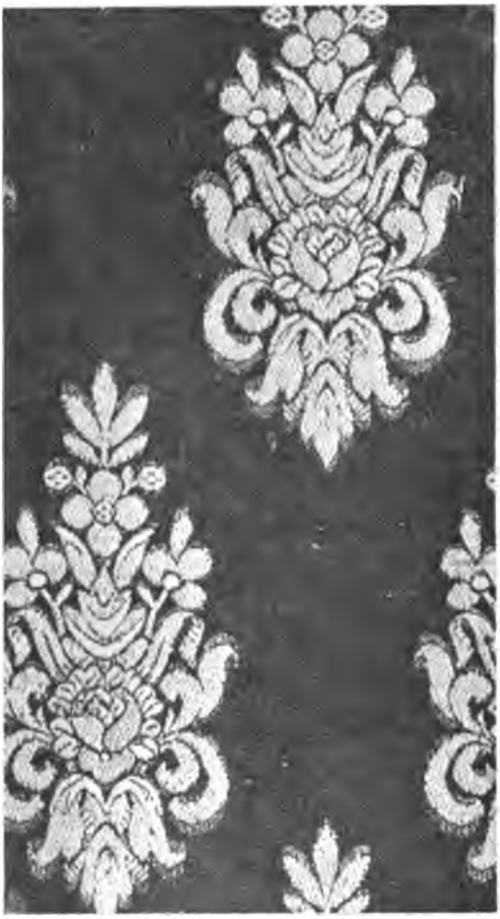


Fig. 145.

Continuous Figuring in One Extra Warp.—Fig. 145 represents an extra warp figured fabric, in which the ends are arranged continuously in the order of 1 extra.

1 ground. The example is a style in which the extra ends are floated on the back during weaving, but are cut away in the finishing processes, and the figure is therefore stitched at the edges. The stitches, however, are so arranged that they soften the outline of the figure, and do not detract from its appearance. A in Fig. 146 shows a portion of the extra warp figure, and B the weave of the ground ends, while C illustrates the method of constructing a point-paper draft of the figure and ground in full for an ordinary jacquard and harness mount. The solid marks indicate the

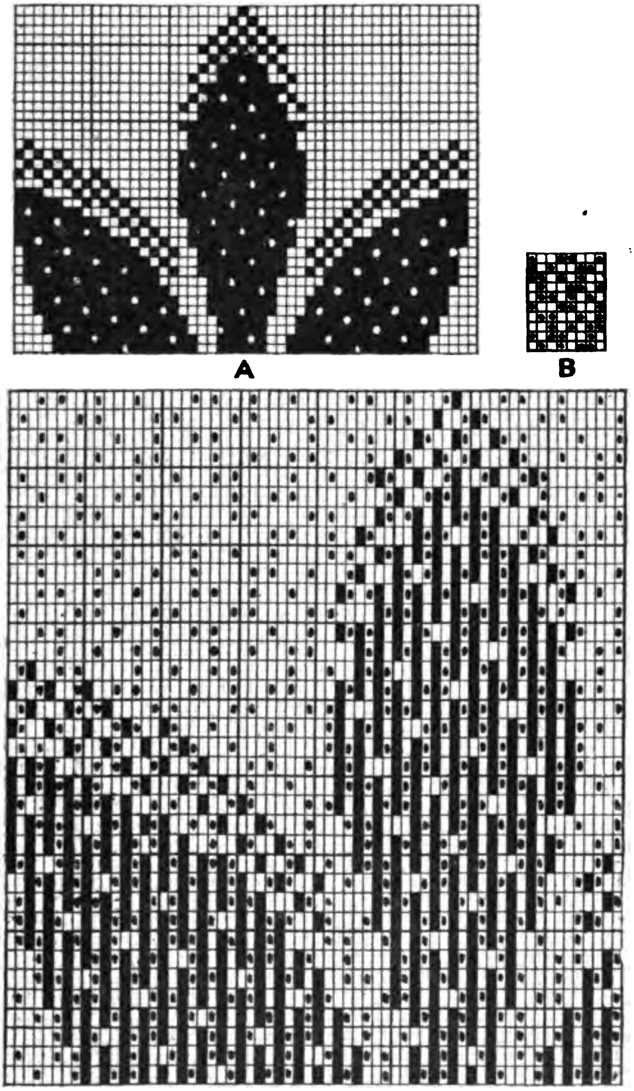


Fig. 146.

lifts of the extra ends which are drawn on the odd harness mails, while the lifts of the ground ends are represented by the dots, a crêpe ground weave being formed.

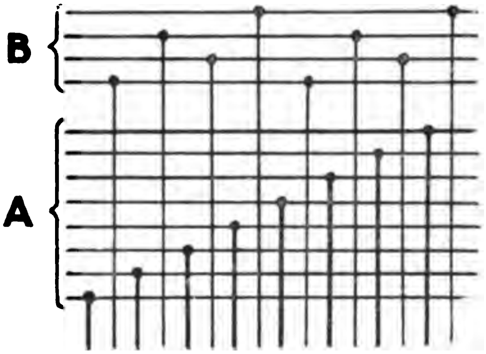


Fig. 147.

The hollow circles in A show a sateen binding weave which is inserted on the figure

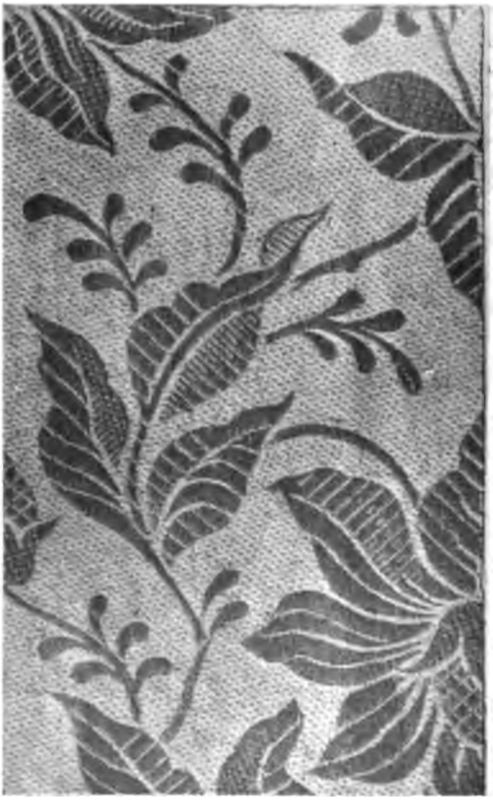


Fig. 148.

to stop the long warp floats. In the cloth the ground ends and picks per unit space are equal, so that, including the extra ends, there are twice as many ends as picks per unit space, and 8 × 4 design paper is therefore suitable in constructing the design in full, as shown at C in Fig. 146.

Heald and Harness Mounting.—One of the simplest modifications of an ordinary jacquard and harness, used in weaving extra warp-figured cloths, consists of mounting healds in front of, or behind, the harness. The figuring ends are drawn on the harness, and the ground ends on the healds, but the method is, of course, only suitable for ground weaves that require a small number of healds. Fig. 147 shows a draft in which four healds B are placed behind the harness A, and can be used for 2 or 4-thread ground weaves. The extra ends can be raised in any desired order by the jacquard, but the use of healds for the ground ends restricts the order in which the latter can be operated; and the foundation weave must be the same under the figure as in the ground spaces. The system, however, enables all the hooks, except a few that may be utilised to lift the healds, to be employed for figuring; while a great advantage is the simplification of the point-paper design, since no regard need be taken of the ground weave. (See also p. 163.)

Alhambra Quilts.—A simple application of the combined harness-and-heald draft is in the manufacture of Alhambra Quilts, in which, as shown in the fabric represented in Fig. 148, a figure is formed in extra warp upon a ground that is ornamented by the extra ends. The figuring ends, which are much thicker than the ground ends (or are woven 2 or 3 per mail), are floated boldly on the surface in forming the figure, while the ground ends interweave in plain order. Substance is given to the cloth by the weft which is very thick and soft spun. The following are suitable weaving particulars of a medium quality of cloth :—

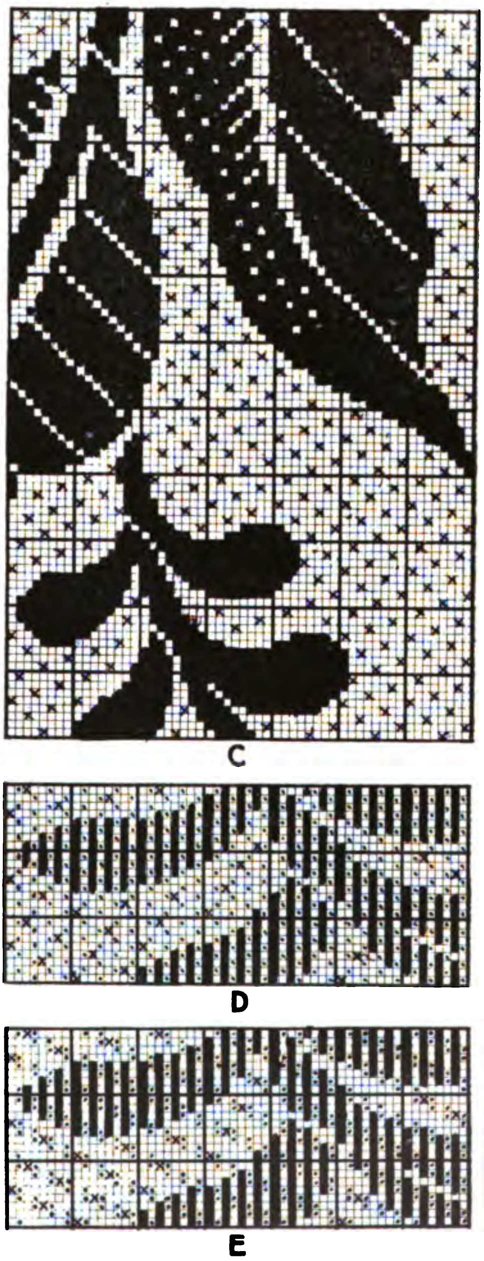


Fig. 149.

Warp: two-ply 16's cotton extra, 20's cotton ground, 29 two-ply, and 29 ground ends per inch.

Weft: 160 yards per ounce bleached cotton, 30 picks per inch.

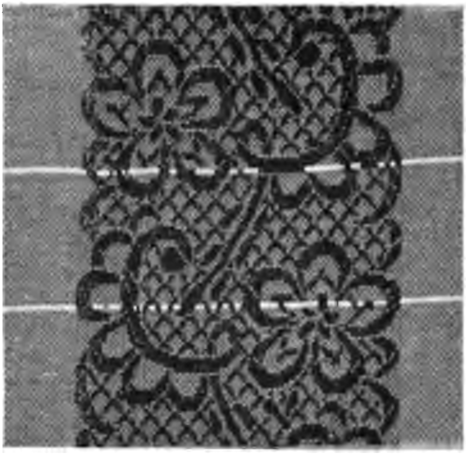


Fig. 150.

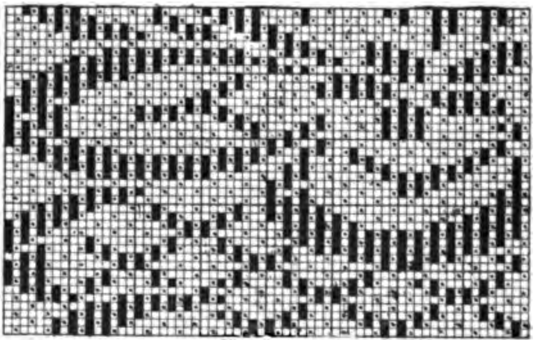


Fig. 151.

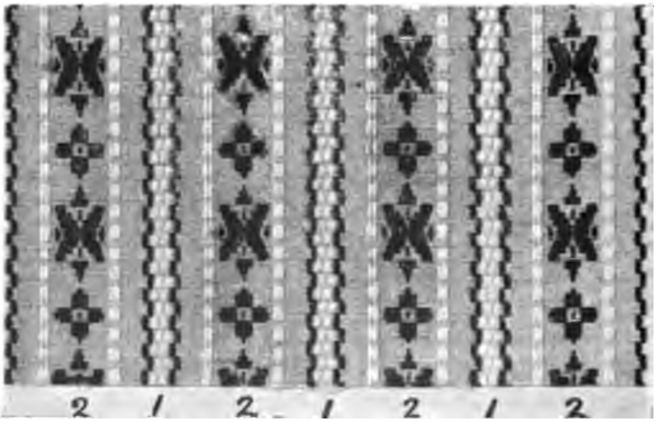


Fig. 152.

From 120 to 125 yards of ground warp, and 106 to 108 yards of figuring warp are required for 100 yards of cloth, while the shrinkage in width is about 5 per cent.

The method of constructing the point-paper design, to correspond with Fig. 148, is illustrated at C in Fig. 149, in which the marks indicate the lifts of the extra ends. After the figure has been painted in solid and suitably developed, a weave is inserted in the ground which may be twill, hopsack, a fancy effect, or, as is shown in the example, a sateen. Every lift of the thick extra warp over the thick weft shows clearly in the ground, and a rich and full appearance is given to what would otherwise be a bare and dull ground. The weight of the extra material is retained in the cloth without the presence of long floats on the back. D in Fig. 149 shows the structure of a portion of C with the plain ground ends included.

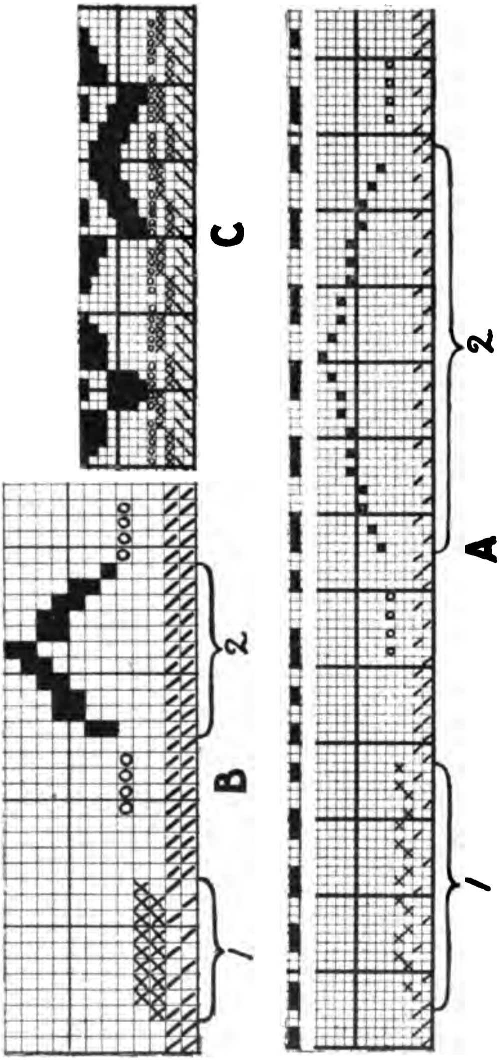


Fig. 153.

Binding in Extra Ends between Face Floats. — In the ground of ordinary extra warp figured fabrics, it is usually necessary for the extra threads to be invisible from the face side, and they can be floated loosely on the back, or if the ground weave is suitable, be bound in between corresponding warp floats. Thus, assuming that 2-and-2 twill ground is formed, the complete structure of the lower portion of C in Fig. 149 will be as indicated at E. With a heald and harness draft, as indicated in Fig. 147, the method of designing, shown at C, can be employed, but care requires to be taken that the healds lift the ground ends in the proper positions in relation to the extra warp stitches.

Intermittent Figuring in One Extra Warp.—The cloths represented in Figs. 150, 152, 154, 155, and 156 illustrate the introduction of one series of extra ends intermittently, and show various ways of forming either stripes or detached figures. In Fig. 150 the stripe figure is due to the continuous manner in which the extra ends are floated. In Fig. 152 the extra figure is not continuous, but the parts are so near together that the figure has a striped appearance which is enhanced by the stripiness of the other parts of the design. In Fig. 154 the extra warp spots are quite separate but are near enough together to show in stripe form, whereas in Fig. 155, the spots are so far apart that the stripe appearance is chiefly due to the introduction of the gauze effect. In Fig. 156, the ornament is entirely due to the extra warp, which is brought up at intervals so as to form detached figures.

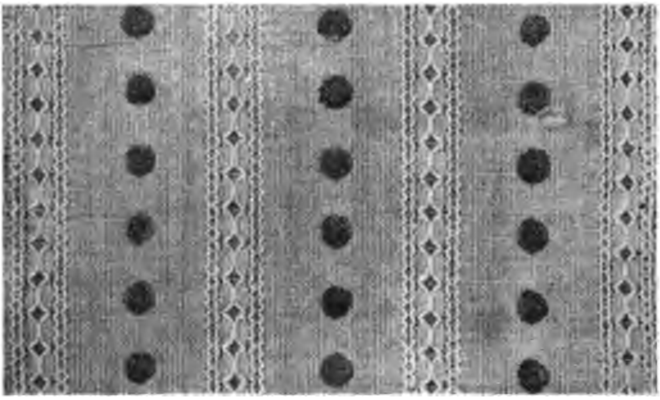


Fig. 154.

Fig. 151 corresponds with a portion of Fig. 150, and shows the method of constructing the design in full, with plain ground, for an ordinary harness mount.

Drafting and Denting Extra Warp Stripes.—Fig. 152 is a dobby style, and the complete design is not given, but A in Fig. 153 shows the draft, with the order of denting indicated above, while C is the pegging plan. For the purpose of illustration the order in which the healds will require to be knitted—assuming that ordinary twine healds are used—is indicated at B. (The method of constructing a heald-knitting plan is described in reference to Figs. 273 and 274.) The stripes numbered 1 and 2 in Figs. 152 and 153 correspond, and if the healds are knitted at the rate of

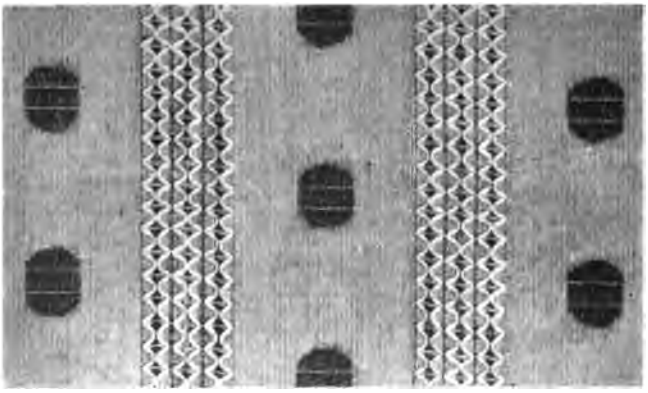


Fig. 155.

the splits per inch of the reed, the marks and blanks of B in Fig. 153, taken horizontally, indicate the order of knitting and missing.

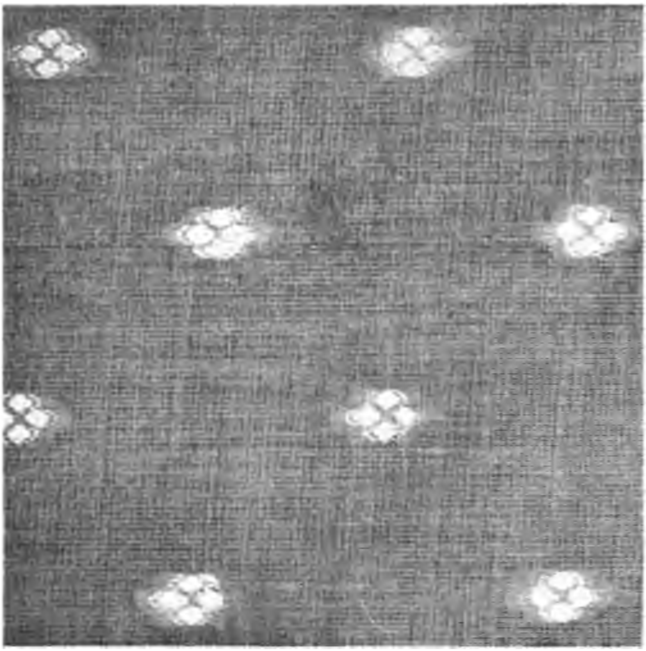


Fig. 156.

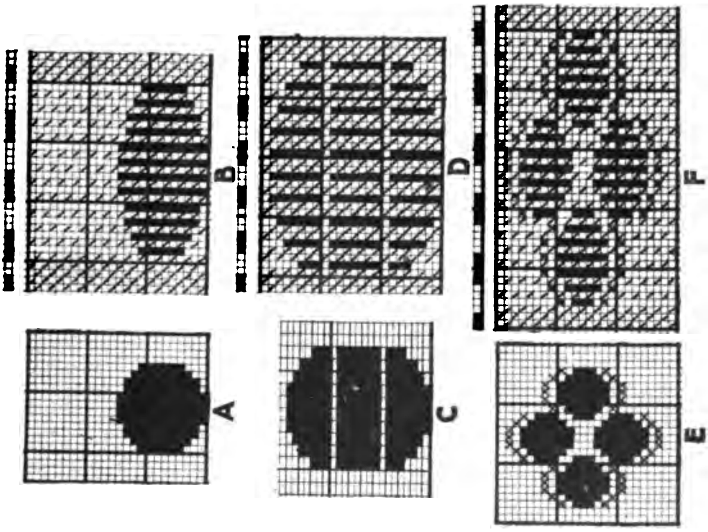


Fig. 157.

The solid plans to correspond with the extra warp spots given in Figs. 154, 155, and 156, are respectively shown at A, C, and E in Fig. 157 ; while the complete structures, with the orders of denting above, are indicated at B, D, and F. In B and F the order of arrangement where the figure occurs, is 1 extra to 1 ground; and in D 1 extra to 2 ground. In each case the ground ends are 2 per split, therefore in B and F the denting in the figure is 4 per split, and in D 3 per split, each extra end in D being placed in a split with a ground end on both sides.

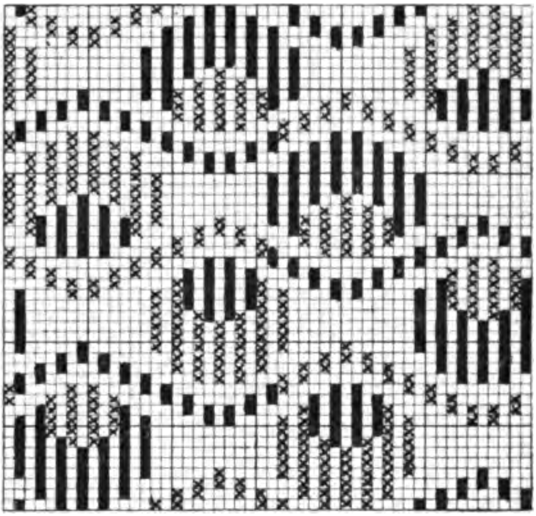


Fig. 158.

In the example represented in Fig. 156 the extra ends between the spots are cut away from the back of the cloth, and, as the figure is in loose float on the surface, in order to prevent the threads from fraying out, they are stitched in at the edges of the figure, as shown by the crosses in the plans E and F in Fig. 157. It will be noted in Fig. 156 that the stitching gives a blurred appearance to the outline so that the spots are not clearly defined.

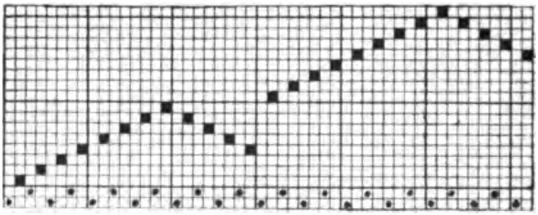


Fig. 159.

From an examination of the denting plans, given in conjunction with the foregoing examples of intermittent extra warp figures, it will be seen that the ground ends are uniformly distributed, which is a very important matter

Figuring with Two Extra Warps.—Fig. 158 shows a style in which two series of extra ends are introduced continuously. A feature of the example is that the complete design extends over 50 extra ends, whereas the order of interlacing repeats upon 25 ends. This is due to the figure having been designed upon an odd number of ends, which causes the colours to change positions in succeeding repeats. The warp colours are also interchanged in the direction of the length of the design. The half-repeat in width of Fig. 158 shows the card-cutting plan for a heald-and-harness draft; and in weaving jacquard designs the method can be employed to obtain a width of repeat that appears to require twice as many needles as are actually necessary—*e.g.*, a figure repeating upon 399 extra ends will produce an effect extending over 798 extra ends. The system can be also used to produce a large repeat in dobby weaving, and in Fig. 159 the complete draft is given for the design shown in Fig. 158, assuming that the ground weave is plain.

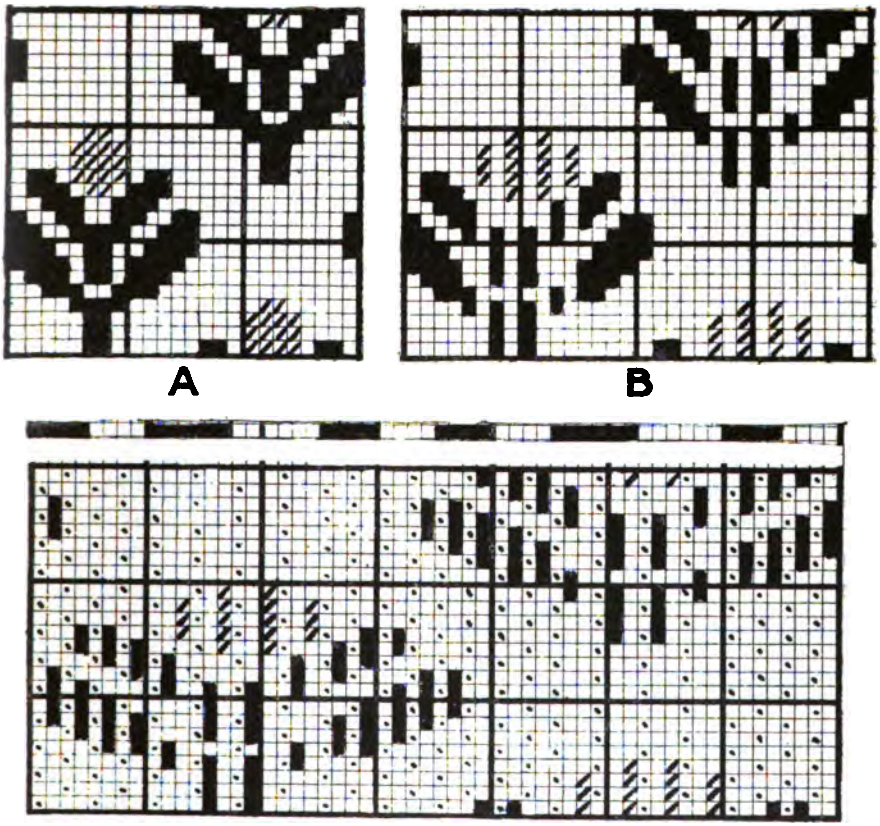

A
B
C

Fig. 160.

Fig. 160 illustrates a simple arrangement (which is applicable to elaborate designs) in which one extra is introduced continuously, as shown by the solid marks, and a second extra intermittently, as indicated by the strokes, the former being used to form what may be termed the ground pattern, while the latter assists the first in producing a figure in two colours. The intermittent extra can also be used to form detached spots, etc., independent of the other. A shows a convenient method of first indicating the figure on design paper; at B the complete plan for the card-cutting is given, assuming that healds are employed in producing a plain ground texture; while C represents the complete structure, and also the card-cutting plan for a full-harness mount.

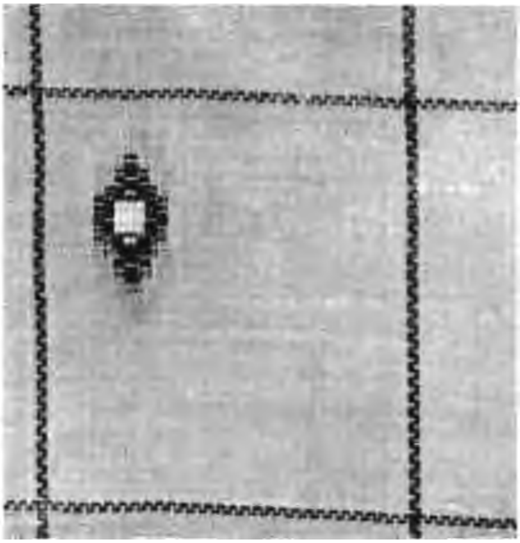


Fig. 161.

The fabric represented in Fig. 161 shows a detached spot figure, which is formed in two extra warps both of which are cut away between the spots. The firm interweaving of the extra ends at the edges of the figure, in this case, forms part of the effect. The spot is formed of coloured and bleached white mercerised cotton on a natural coloured cotton ground, and there is an overcheck of coloured mercerised cotton, which is not extra, but simply crammed. A portion of the complete design is given in Fig. 162, the full squares representing the coloured mercerised, the diagonal marks the white mercerised, and the dots the ground. The denting order is indicated above, and it will be noted that within the overcheck there are two ground ends to each split, giving four ends per split where one extra only is employed, and six ends per split where both extras are introduced.

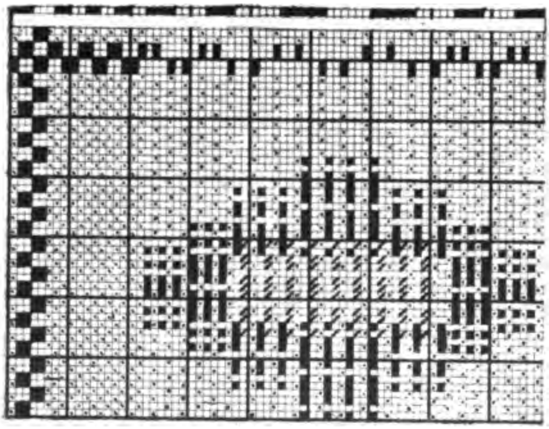


Fig. 162.

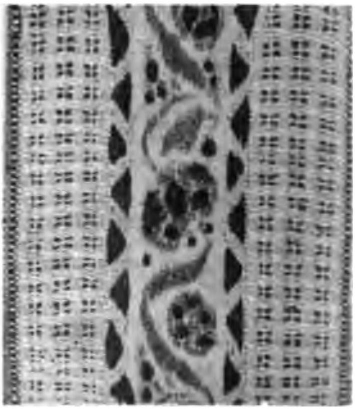


Fig. 163.

In Fig. 163 an extra warp stripe in two colours arranged one of each to each ground end—is shown combined with a 5-and-1 mock leno effect, while plans to correspond are given in Fig. 164. In designing an effect in more than one extra, it is convenient to first paint the figure solid in different colours on the point-paper, as shown at A in Fig. 164, in which different marks are used to represent the colours. For the card-cutting, if the ground texture is produced by healds, the figure under ordinary circumstances, will require to be extended, as shown at B; and for a full-harness mount, as indicated at C. The mock leno weave is given at D, for which a suitable order of denting is: 5 ends in 3 splits, 1 split missed, 1 end in 1 split, 1 split missed, as indicated above the plan D. E shows the weave of the fancy corkscrew effect which is formed on each side of the extra warp stripe in Fig. 163.

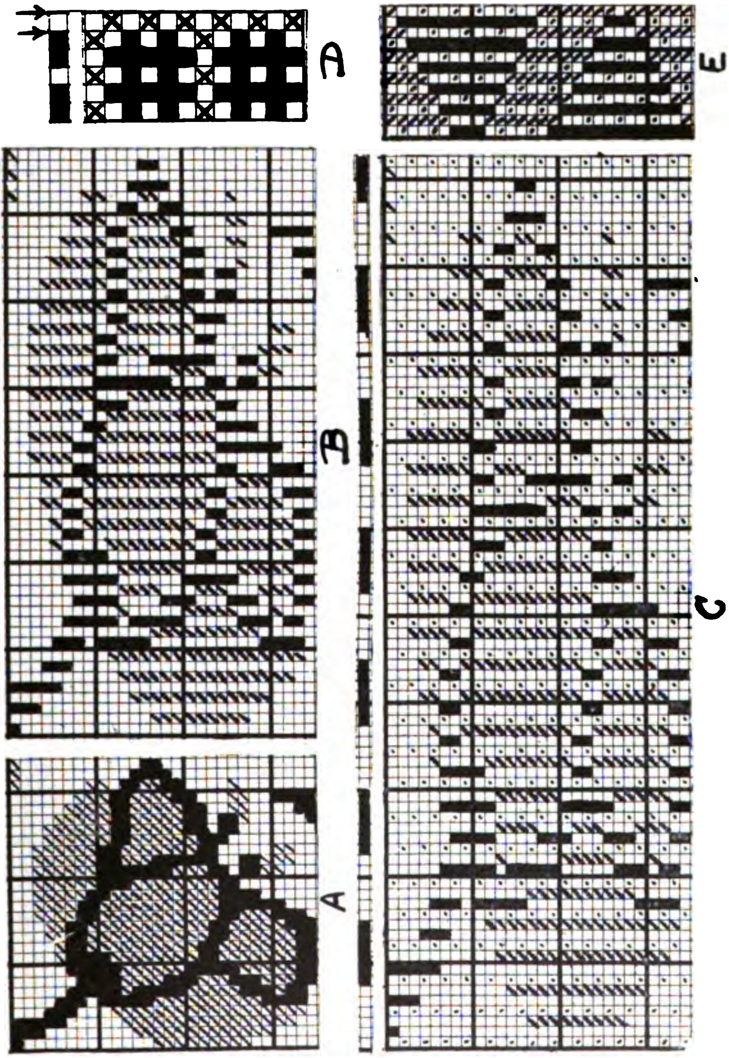


Fig. 164.

Fig. 165 also shows a combination of an extra warp figure in two colours with imitation gauze, but in this case there are two ground ends to each colour of extra, while the mock leno weave is 3-and-3. The corresponding sectional plans are given in Fig. 166, A showing the figure marked solid, and B the extension of a portion without the ground ends. The complete structure is indicated at C in which the ends are arranged in the order of: ground, first extra; ground, second extra. D shows the imitation gauze weave, which is dented 3 per split, 1 split missed. In B and C the long floats of one extra on the back are shown stitched between the surface floats of the other extra. (Combinations of extra warp figures with true gauze effects are illustrated in Chapter XII.)

Stitching by means of Special Picks.—When it is desired to retain the extra ends on the under side of a cloth without leaving them to float loosely between the figures, and when the ordinary method of stitching them between face floats of the ground ends is not feasible, the system, illustrated in Figs. 167 and 168, may be employed. The method is the same in principle as that illustrated in reference to extra weft figures in Fig. 126 (p. 118), but in this case special binding picks are employed to stitch the extra ends on the underside. The arrangement is applicable to any number of extras, and to either continuous or intermittent orders.

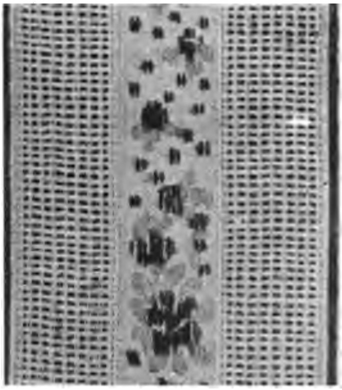


Fig. 165.

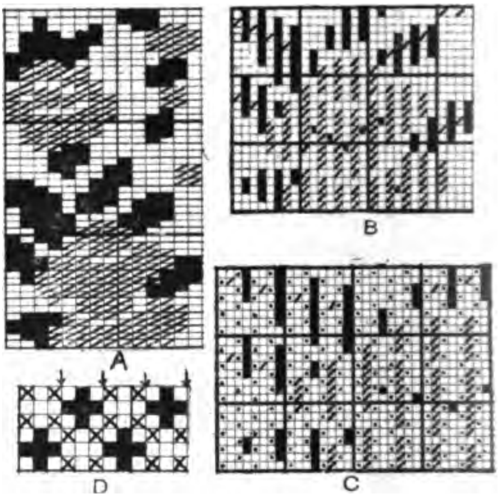


Fig. 166.

The upper portion of Fig. 167 shows the face of the cloth, and it will be noted that the ground, which is plain weave, is quite free from the extra ends, yet, as shown in the lower portion of the figure, on the underside they are firmly bound in. F in Fig. 168 illustrates the method of indicating the figure on design paper for a heald-and-harness mount; G shows how the ground ends interweave with the picks: H is the heald draft for the ground ends, and I the lifting plan for the healds; while at J the complete weave of a portion of J is indicated. The weft is the same throughout, but every fifth pick is used as an extra binding pick which floats under 9 and over 1 ground end, as shown at G. On the binding picks all the extra ends are raised where figure is formed, but in the ground portions of the cloth they are lifted alternately. Really, the binding picks form a plain back cloth with the extra ends where the latter are not required to form the figure, but the alternate interweaving of the binding picks in 9-and-1 order with the ground ends, as shown by the fifth and tenth picks in G, firmly unites the back to the face. The interweaving of the binding picks with the ground ends, however, causes slight indentations to show in the face of the cloth. For a heald and harness mount a card is cut from each horizontal space of the design F to correspond with a ground pick, and an extra card from every fourth space for the binding picks. The card cutting particulars of F are: Cut the figure on the ground picks, and the figure and the blanks plain on the binding picks. In addition, the lifts of the healds, indicated at I, will require to be cut opposite the needles that are used to operate them.

In K, Fig. 168, the solid line shows how the tenth pick of J interlaces, and the dotted line the ninth pick, the extra ends being represented as larger in diameter than the ground ends; while L shows the interweaving of the last three ends of J, the solid line representing end 38, the dotted line end 40, and the thicker shaded line the extra end between them.

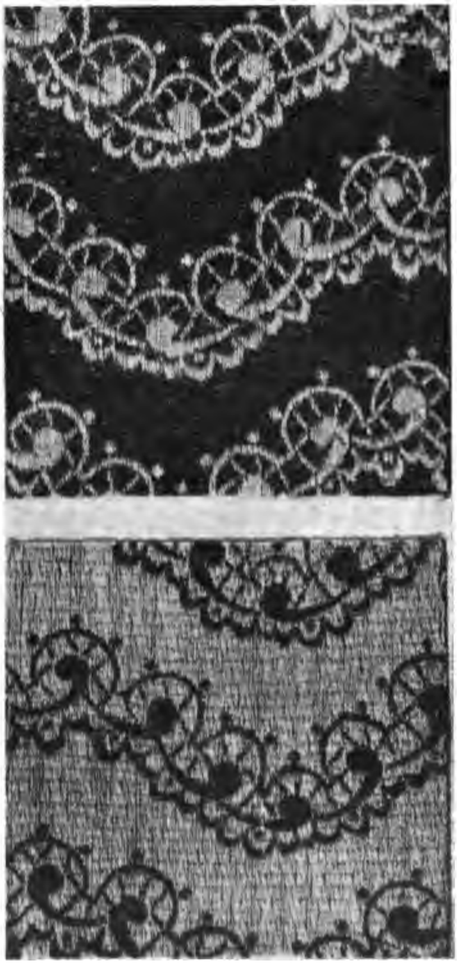


Fig. 167.

Extra Warp Planting.—The design A in Fig. 169 illustrates a system of arrangement termed "planting," which enables a figure to be formed in a large number of colours without an addition being actually made to the series of extra threads. (The method corresponds to "chintzing" the weft, previously referred to—p. 126). In the example 5 colours (represented by different marks) are employed, but it will be noted that two colours only are introduced in any vertical line of the design. So far as regards the number of extra threads the arrangement is thus equivalent to a two-colour extra. The order in which the colours replace each other can be observed by following the spaces horizontally in the "gamut" indicated above A.

End-and-End Figuring.—In some Eastern styles, in which a figure is formed in two or more colours of warp, no ground ends are introduced, but a dark weft is employed which interweaves in a simple order with the figuring ends. B in Fig. 169 shows a portion of the design A thus arranged, the ground weave (represented by the shaded squares) being 5-thread weft sateen, in contrast with the dark surface of which the brightly coloured warp figure shows very distinctly.

A four-colour warp figure is illustrated in Fig. 170, in which there are two features to note—viz., (1) The surface of the cloth is entirely covered by the warp figure, and there are no ground ends, the necessary firmness of structure being obtained by interweaving each colour, where forming figure, in 3-and-1 twill order; (2) Variety of effect is obtained by the interchange of the colours in succeeding repeats. Thus, an examination will show that, while the complete design is on 64 picks, the figure in the upper half is exactly like that in the lower half, except that the colours, represented by the full squares and crosses, interchange. A in Fig. 170 shows how the figure may be conveniently indicated by first marking the different

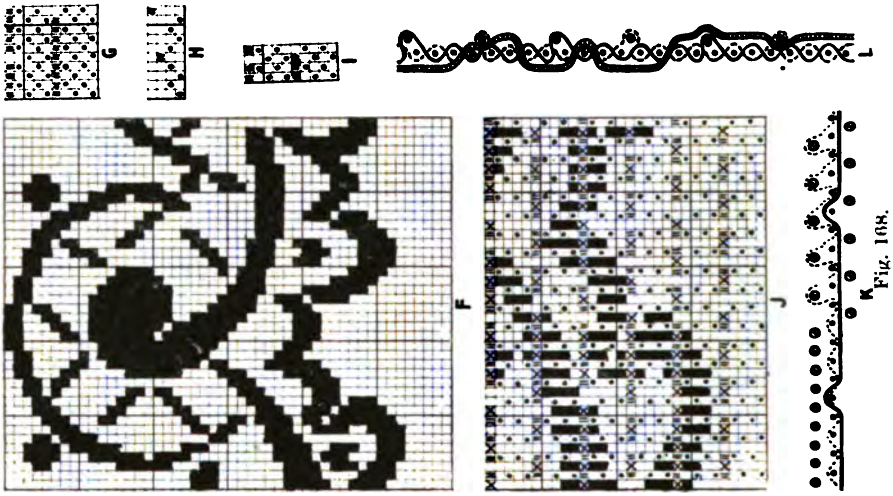


Fig. 168.

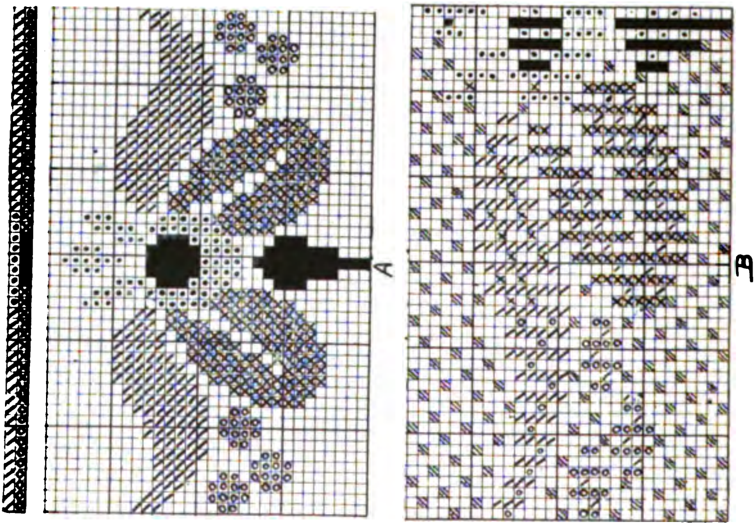


Fig. 169.

colours solid, and then inserting 1-and-3 twill entirely over the design; while B shows the complete structure of the first eight ends of A.

Reversible Warp-Face Figured Fabrics.—This class of structure can be produced in a similar manner to reversible weft-face fabrics by employing different colours in the warp. The construction of the weaves that are combined will be illustrated by turning Fig. 143 (p. 129) one-quarter round, and taking the marks to indicate warp. The designing of reversible warp effects and extra warp styles in which more than one series of extra ends are employed is very much simplified if a sectional harness arrangement, such as is illustrated in Fig. 183 or Fig. 184, is used.

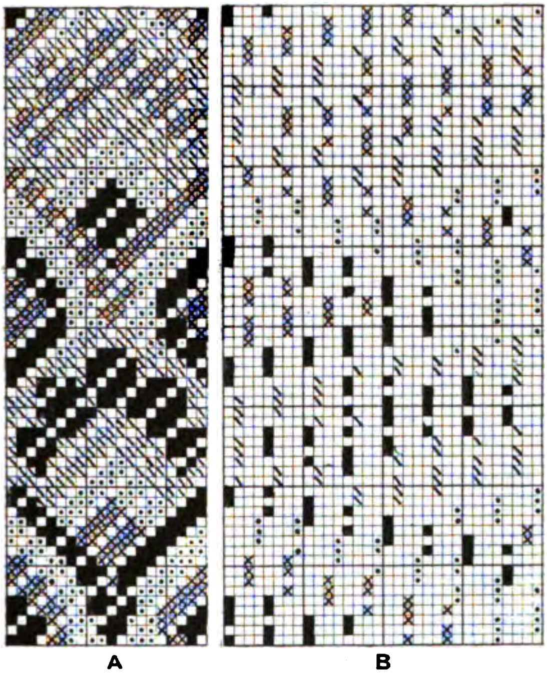


Fig. 170.

CHAPTER VII

FIGURING WITH EXTRA WEFT AND EXTRA WARP

Economical Use of Extra Materials—Extra Warp and Extra Weft Spotting. Double Weave Combinations—Designs Produced in Double-Plain Weaves—Double Twill Weaves—Combination of Fine and Coarse Fabrics—*Combinations of Double Weaves and Warp and Weft Float*—Crepon Structures—Double Weave and Weft Figure on Warp-Rib Ground.

Economical Use of Extra Materials.—The combination of extra weft and extra warp threads gives very great scope in the development of designs, and for certain styles of ornament is more economical than when only one of the series of threads is employed. For instance, a fabric is represented in Fig. 171, in which an all-over figure has been produced in extra weft and extra warp with comparatively a small consumption of extra material. In the corresponding design given in Fig. 172, in which the marks represent warp, the full squares indicate the positions of the extra threads, which are arranged in warp and weft in the order of 1-and-6 with the ground threads. A special feature of the example is that the surface of the cloth is made perfectly plain by allowing each extra end and pick respectively to interchange with the preceding ground end and pick. Thus it will be seen that where an extra thread interweaves plain on the surface, as indicated by the solid marks, the ground thread which precedes it floats on the back, while where an extra thread floats on the back the ground thread is brought to the surface in plain order. If the ground threads had been interwoven in plain order throughout, the plain weave of the extra threads would have been the same as the preceding ground threads, and the former would have been partly concealed by the latter.

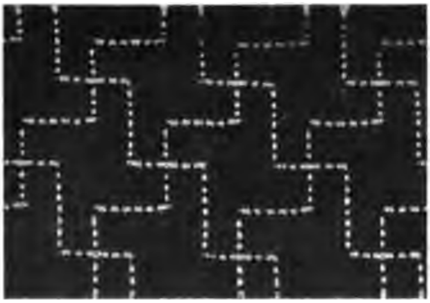


Fig. 171.

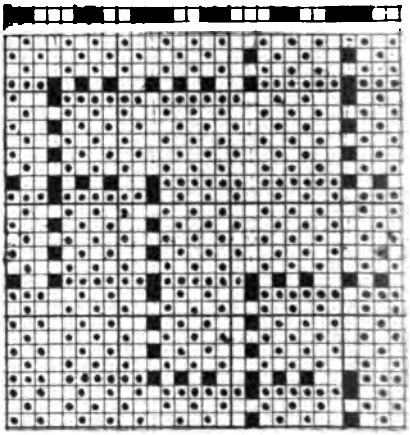


Fig. 172.

Extra Warp and Extra Weft Spotting.—A muslin fabric is represented in Fig. 173, which shows detached figures formed by floating extra warp and extra weft threads in combination, and small spots produced by the extra warp alone. A convenient method of first indicating the combined weft and warp effect is illustrated at A in Fig. 174, in which the solid marks indicate the weft figure and the dots the warp figure. The surplus warp and weft threads are sheared off the underside of the cloth.

but the weft is so firmly interwoven in the figure that no stitches are required at the edges. In the warp figure, however, the ends are loosely interwoven, and they are therefore stitched with the ground picks, as shown by the circles in A, above and below the warp floats. Each horizontal space of A represents a ground pick, and where weft figure is indicated, also an extra pick, while each vertical space represents a ground end, and where the warp figure is shown, an extra end also. The ratio of ground ends to ground picks per inch—in this case 64 to 48—gives the proper counts of point-paper in designing the figure solid, and 8 × 6 paper is therefore shown at A.

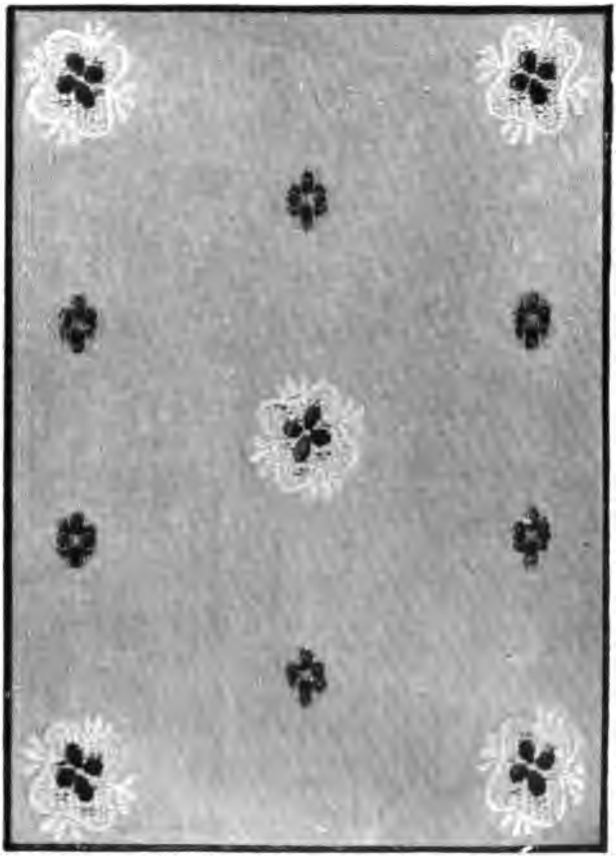


Fig. 173.

With a sectional harness arrangement (see p. 156) the cards could readily be cut from the solid design given at A, but if an ordinary harness mount is used, it is necessary for the design to be extended, as indicated at B, in order to show the working of the extra ends. B is the same as A except for the inclusion of the extra ends which are marked down in places where they are not lifted to form figure or for stitching. The order of denting is indicated above B, in which it will be seen that twice as many ends are placed in each split where the extra warp is introduced, as in the remaining parts of the design.

In the extra weft figured portions of the design a figuring and a ground card are cut from each horizontal space, and in the remaining portions a ground card

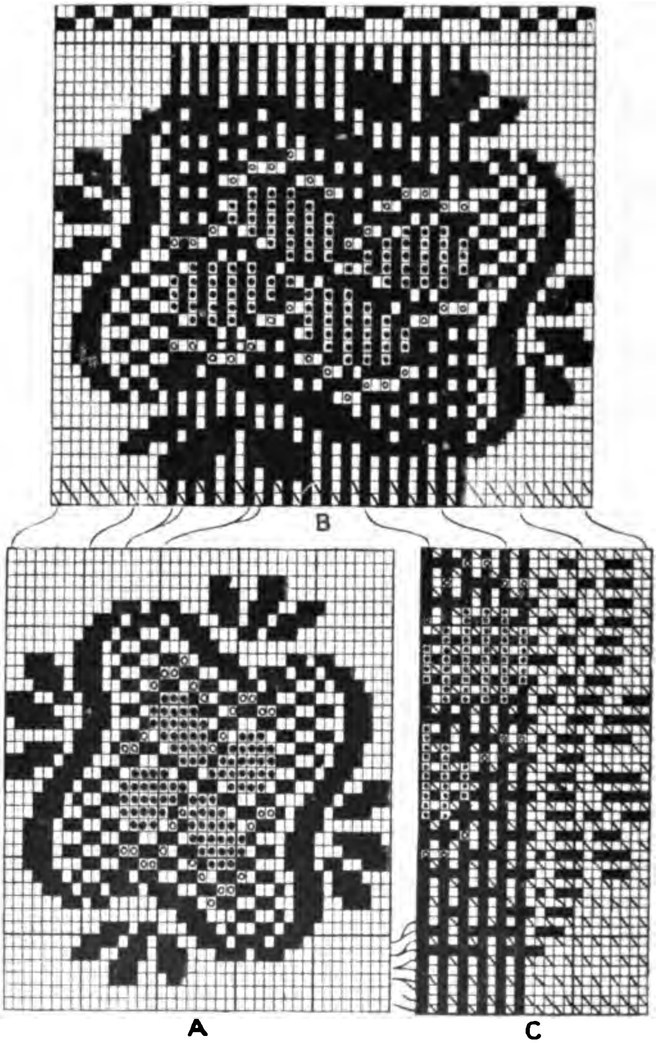


Fig. 174.

only. On the first two picks of B in Fig. 174, the diagonal marks indicate the order of cutting by which the ground ends and picks are interwoven in plain order. The odd ground cards are cut like the first pick of B, and the even ground cards like the second pick; but in addition, the extra warp lifts are cut where the latter are indicated by the dots and circles. On the extra weft figuring cards, all but the solid marks and circles are cut. The complete weave of the first 24 picks and the last 24 ends of B is represented at C in Fig. 174. (The circles in C, which indicate the extra warp stitches, should be situated one pick later.) The ground ends and picks form plain weave throughout the cloth, and a feature to note is that where the extra warp figure is formed the extra weft lies between the plain foundation and the warp floats, the latter being thereby shown up very prominently.

DOUBLE-WEAVE COMBINATIONS

In their simplest form figured double cloths are a development of the interchanging double-weave effects described and illustrated in Chapter III., in which two separate fabrics are formed one above the other in every part of the cloth. The threads of one fabric require to be different from those of the other, in respect to either thickness, material, or colour, in order that the design will be visible, while the number of threads in the two fabrics may be in either equal or unequal proportions. The appearance of a double-weave texture is represented in Fig. 175, in which a dark figure is formed in silk yarns upon a light worsted foundation. When the two fabrics are alike except as regards colour, the cloth is generally reversible; a dark figure on a light ground on one side corresponding with a light figure on a dark ground on the other side. This is illustrated at E and F in Fig. 1. Figured double cloths, as produced in special jacquards and harnesses, are fully dealt with in subsequent chapters, therefore only the method of designing the styles for ordinary machines is considered here.

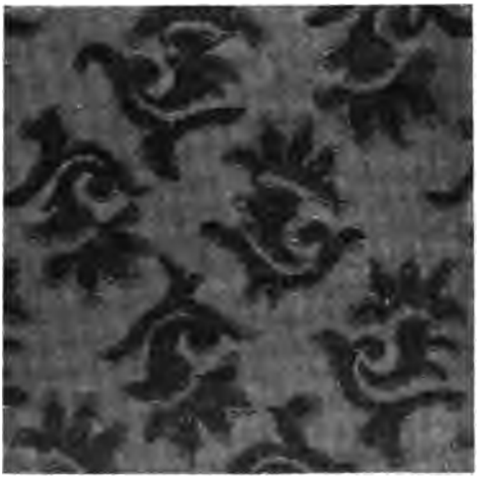


Fig. 175.

The double weaves that are chiefly combined are illustrated in Fig. 176, in which the marks indicate warp. The order of arranging the threads, as to colour or material, is shown by different marks along the bottom and at the side of the examples; the positions of the backing ends and picks are indicated by the shaded spaces, above which the complete double weave is given.

Designs Produced in Double-Plain Weaves.—Double-plain weaves are largely employed in combination, and a number of plans are given at A to H in Fig. 176, which illustrate various effects that can be formed in a 1-and-1 order of warping and wefting. Two methods of arranging the threads are shown, however, viz.: (1) the weft and the warp in the same two colours—represented by the solid marks and shaded squares; and (2) the warp in two colours—represented by the solid marks and shaded squares, and the weft in two different colours—represented by the crosses and dots. Above each double weave A to H, and linked with the order of colouring, the colour effect that is produced on the surface is represented by corresponding marks; the lower row of plans showing the effects formed with the warp and weft in the same two colours, and the upper row with the two warp colours different from the two weft colours. The threads on the surface in the respective weaves are as follows:—A, odd ends and odd picks; B, even ends and even picks; C, odd ends and even picks; D, even ends and odd picks; E, odd ends and first and second picks; F, even ends and third and fourth picks; G, second and third ends, and second and third picks; H, first and fourth ends and first and fourth picks. (Figs. 185 and 218 show special methods of forming double plain weaves.)

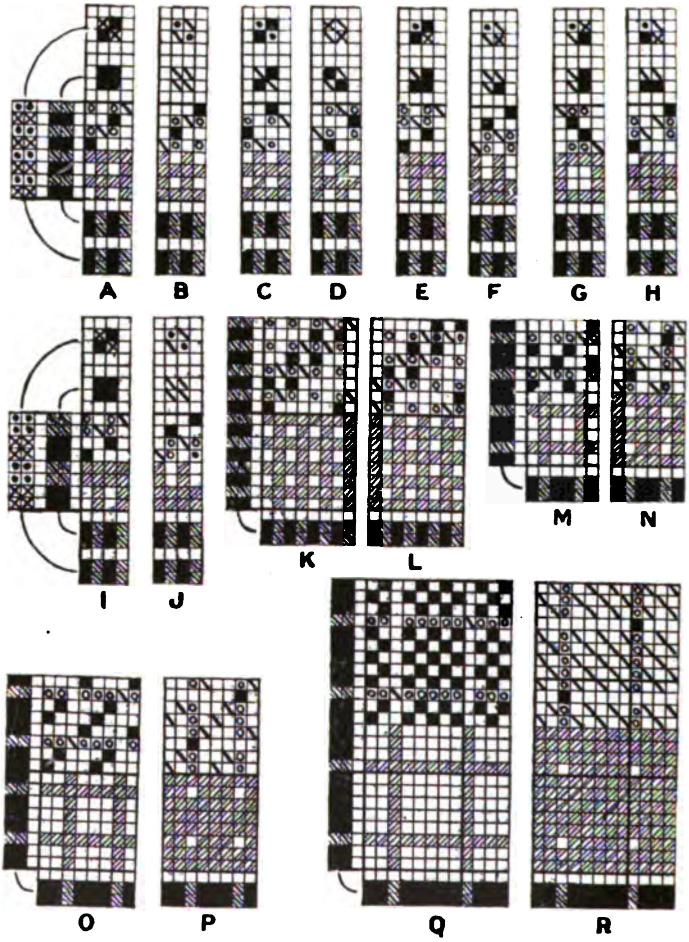


Fig. 176.

The plans I and J in Fig. 176 produce similar effects to A and B, with the weft arranged in 2-and-2 order to suit a loom with changing boxes at one end only. It will be seen that the weaves I and J are respectively the same as E and F, and the other weaves A, B, C, D, G, and H can be used in combination in the 2-and-2 order of wefting to obtain diversity of effect.

Each weave A to J produces two separate plain fabrics, and in designing a figured style two or more of the weaves are combined. After the outline of the figure has been drawn on the design paper, the different effects are lightly indicated in different colours of paint, and then the proper weaves are inserted in the respective sections and in the ground. The method is illustrated by the example given at N in Fig. 70 (p. 74), in which the weave marks indicate weft. Also a simple geometric style, suitable for a vesting fabric, is shown in Fig. 177, in which the weave marks indicate warp. A method of producing neat, unpronounced effects, in such cloths as vestings, consists of using a twist yarn for the figure, in which one of the threads is the same colour as the ground threads—*e.g.*, a combination of black with black-and-white twist threads.

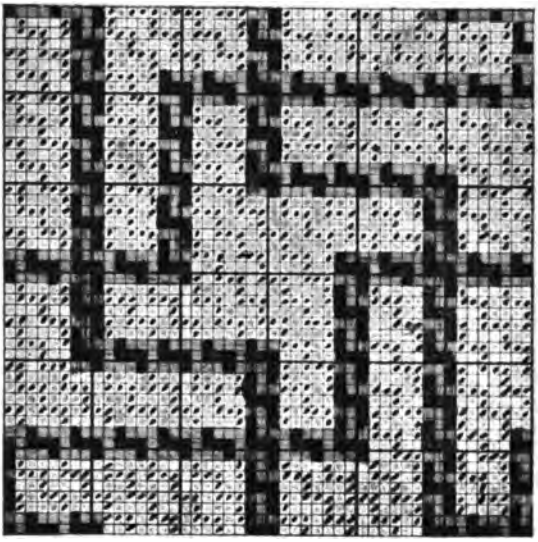


Fig. 177.

Double-Twill Weaves.—Double-twill weaves can be readily arranged and combined in the same manner as the double-plain. The double 2-and-2 twill is shown at K and L in Fig. 176, the former bringing the odd ends and picks to the face and producing a dark surface, and the latter the even ends and picks which produce a light surface.

Combination of Fine and Coarse Fabrics.—Figured effects are also formed by interchanging a fine fabric with an open, or coarse fabric. Thus M and N in Fig. 176 show two opposite double-plain weaves, in which the threads are arranged in the proportion of two to one. M brings the fine ends and picks to the surface, and N the coarser ends and picks, so that by combining the two weaves a figure in thick yarns may be formed upon a fine foundation, or *vice versa*. The plans O and P are opposite

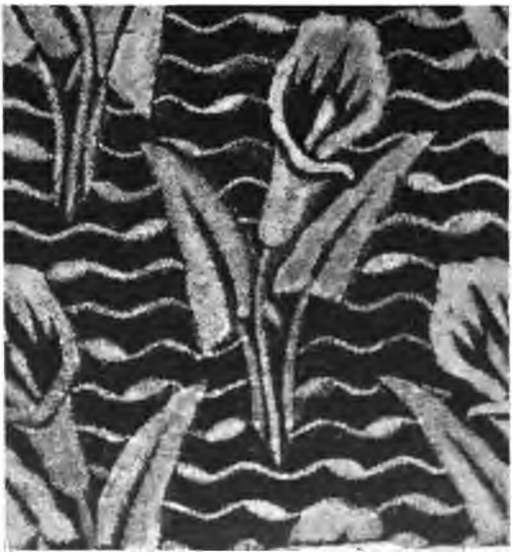


Fig. 178.

double weaves in which the threads are arranged in 3-and-1 order; the threads of the fine fabric forming 2-and-1 twill, and those of the coarse fabric plain weave. Q and R are opposite double-plain weaves in which the threads are arranged in 5-and-1 order; the open fabric in this case should be composed of very much thicker threads than the fine fabric.

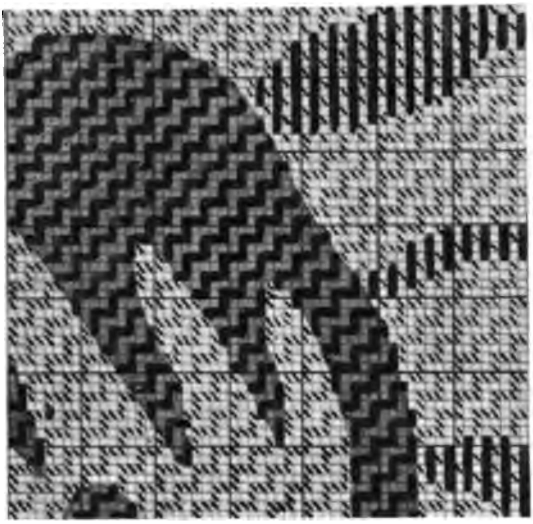


Fig. 179.

Combinations of Double Weaves and Warp and Weft Float.—In addition to forming figure by interchanging the fabrics variety of effect can be produced by floating the warp or weft threads loosely on the surface. Fig. 178 represents a texture in which a figure is formed in coloured silk yarns upon a black worsted foundation, the particulars of the cloth being: 1 thread 2/60's botany, 1 thread three-ply 60/2 spun silk in warp and weft; 72 ends and picks per inch. As shown in the corresponding sectional design given in Fig. 179, in which the marks indicate warp, the cloth is chiefly double plain, but additional interest is given to the design by forming the waved horizontal lines in floats of the silk warp. The worsted and silk picks interweave plain with the worsted ends underneath the warp figure. (See also p. 190.)

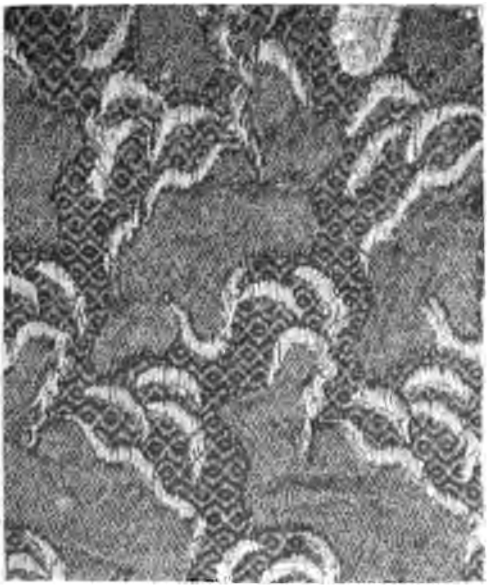


Fig. 180.

The fabric represented in Fig. 180, and the corresponding sectional design given in Fig. 181, illustrate the combination of a double-plain weave with an extra warp figure effect. The particulars of the cloth are: 1 end 2/40's mohair worsted, 1 end 2/40's cotton. 76 ends per inch; weft, all 40's cotton, 60 picks per inch. The mohair ends are on the surface in the double-plain portions of the cloth, and they produce an extra warp figure and a fancy diamond effect upon a plain foundation that is formed by the cotton ends and picks.

Crepon Structures.—Fig. 180 illustrates the figured "crepon" class of texture in which a waved or cockled surface is produced. The effect is due partly to the weave structure and partly to the combination in the cloth of yarns which have different shrinking properties. Hard-twisted botany worsted threads readily shrink when scoured, as also do cotton yarns when they are immersed in a solution of caustic soda, but neither process has much effect upon the length of mohair and silk threads. In a cloth in which an unbound effect in mohair or silk is formed upon a foundation of hard-twisted botany or cotton, the conditions are favourable for giving full play to the different shrinking properties of the materials. The result is that as the foundation yarns shrink, the non-shrinking threads, which are floated loosely, tend to form curls or loops on the surface, while in the double-weave portions of the cloth the slack upper fabric forms ridges and hollows. The crepon effect, shown in Fig. 180, has been produced by the caustic soda treatment, which caused the cloth to shrink 21 per cent in width and length.

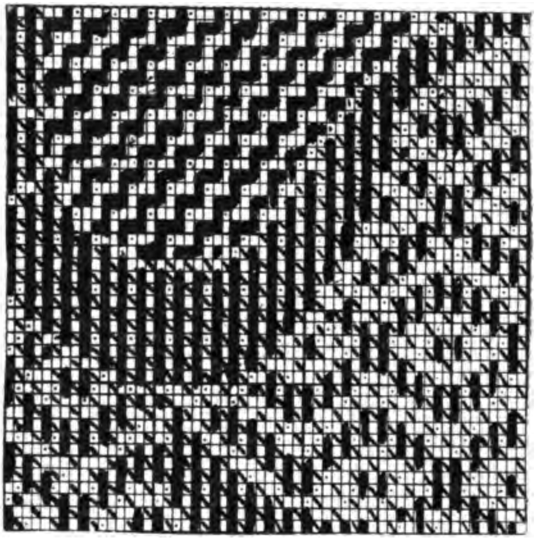


Fig. 181.

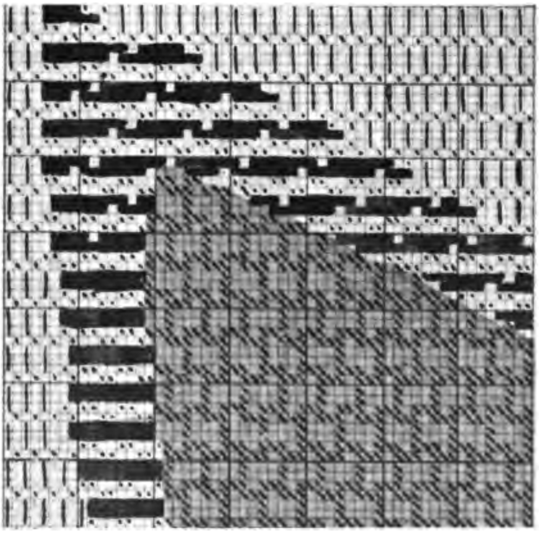


Fig. 182.

Double-Weave and Weft Figure on Warp-Rib Ground.—Fig. 182, in which the marks indicate weft, shows the combination of a double-weave, weft figure, and 3-and-1 warp-rib ground. In the warp the arrangement is 1 end of two-ply spun silk, and 1 end worsted. and in the weft, 2 picks of two-ply spun silk, and 2 picks of worsted; the plan in Fig. 182 commences with one pick of silk. In the rib ground the worsted ends are chiefly on the surface, the two worsted picks and one silk pick going into the same shed. In the double weave the silk warp and weft form a plain upper fabric, and the worsted warp and weft a 2-and-2 rib under fabric. The double-weave figure is surrounded by floats of the worsted weft.

CHAPTER VIII

SPECIAL JACQUARD AND HARNESS MOUNTINGS AND SYSTEMS OF DESIGNING

Comparison with Ordinary Jacquard and Harness Mounts. *Sectional Jacquard and Harness Arrangements*—Sectional Harness Ties—Special Connection of Hooks and Needles—Special Draft of the Warp Threads—Designing and Card-Cutting for Sectional Arrangements. *Methods of Increasing the Figuring Capacity of Jacquards*—Inverted Hook Jacquards—Combinations of Healds with Harnesses—Combinations of Lifting Rods or Bars with Jacquard Machines. *The Split Harness or Shaft Monture*—Operation of the Lifting Rods—System of Designing. *Working Comber-Boards.*

Comparison with Ordinary Jacquard and Harness Mounts.—The chief advantage of the ordinary type of jacquard and harness [*]—usually termed a full or thread harness—is that any desired weave may be employed in both the figure and ground of a cloth, because every end in the repeat can be operated independently in any order. The system has the disadvantage that the size of the repeat is limited, because each card only corresponds to one pick, and each needle to one end, the weaving of very large designs thus being both inconvenient and costly. Also, the full harness system, except in a few cases—*e.g.*, extra weft-figured fabrics—necessitates the complete working of every end and pick to be indicated upon the point-paper design, which for complex cloths is a very long and tedious process. Special modifications of the ordinary jacquard and harness arrangements have therefore been devised, each of which has one or more of the following objects chiefly in view: (*a*) To simplify the painting-out of designs; (*b*) to reduce the cost of cards and card-cutting; and (*c*) to obtain a large repeat from a comparatively small jacquard. In most special mountings, however, one or more limitations are imposed which are not common to an ordinary machine, and which vary according to the form of the mounting.

SECTIONAL JACQUARD AND HARNESS ARRANGEMENTS

Sectional systems of mounting are used in the manufacture of cloths which are composed of two or more different kinds of warp threads—arranged alternately, or in 2-and-1 order, etc., with one another—each of which has a separate function in forming the design or the structure of the fabric. Except when employed in conjunction with a special harness mount (*e.g.*, working comber-boards), the object of a sectional arrangement is solely to simplify the processes, and reduce the cost of painting-out designs and card-cutting. There is no saving, as compared with an ordinary form of jacquard and harness, in either the number of hooks, or the number of cards required for a design.

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[*] The ordinary forms of jacquard and harness, ordinary and special harness ties, and jacquard, harness, and design calculations are described and illustrated in the accompanying book: TEXTILE DESIGN AND COLOUR—ELEMENTARY WEAVES AND FIGURED FABRICS.

The different kinds of warp threads must follow each other in the harness in the order in which they are required in the cloth ; the sectional arrangement enables each kind of warp to be governed by a separate section of the needles, so that the lifts of each warp can be cut independently upon a corresponding section of the cards. Three methods of accomplishing the result are illustrated in Figs. 183 and 184.

Sectional Harness Ties.—In the method shown in Fig. 183, the hooks and needles are connected in the ordinary manner, but a special system of tying up the harness is employed. A separate transverse section of the hooks is allotted to each kind of warp, the number of hooks in the respective sections being in the same proportion as the threads of each kind. From each section of hooks the harness cords are passed through a separate *longitudinal* section of the comber-board to correspond, and each kind of warp is drawn through the harness mails of the section allotted to it. The system is illustrated in Fig. 183 which shows in the upper portion a sectional tie for two kinds of warp arranged in 1-and-1 order. The hooks are divided into two equal parts, A and B, and the harness cords that are tied to the hooks A are passed through the front longitudinal section A of the comber-board, while those tied to the hooks B are passed through the back section B of the comber-board. In the warp draft, which is represented in the lower portion of Fig. 183 the even ends are shown drawn through the harness mails of the front section A, and the odd ends through the mails of the back section B. One half of the needles, taken consecutively, thus governs the even ends, the lifts of which are cut on the corresponding half of each card, while the other half of the needles governs the odd ends, the lifts of which are similarly cut on the other half of each card. In weaving designs, which are so large that two machines placed side by side are required (a twin jacquard), one machine will govern one series of ends, and the other machine the other series ; the two machines being operated as one. This is very convenient for the card-cutting, as the provision of two separate sets of cards enables one warp to be cut for quite independently of the other.

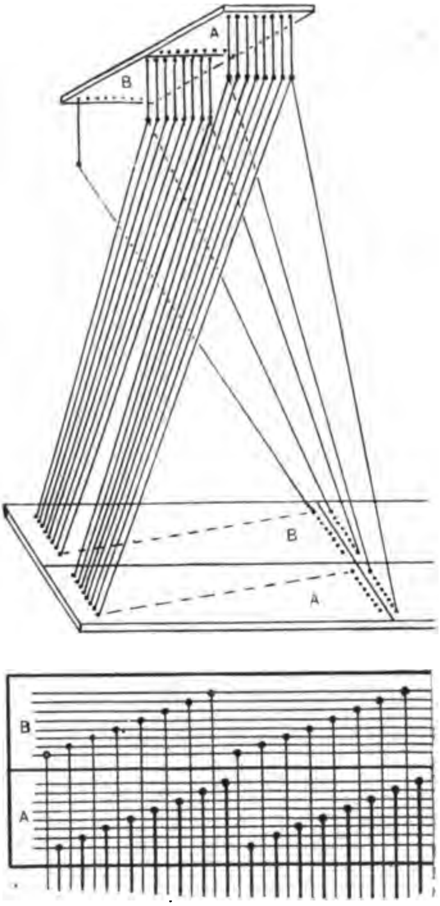

Fig. 183.

Other proportions of the warp threads are arranged in the same manner as the foregoing. Thus, if two series of threads are arranged in the proportion of two to one, the hooks of a 600-machine will be tied up in two sections of 1-400 and 401-600 to correspond, and the harness cords will be passed through longitudinal sections of the comber-board which are respectively 12 holes and 6 holes deep, or 8 and 4. For a three-thread arrangement in 1-and-1 order, the hooks and needles of a 600-machine will be in three equal sections—viz., 1-200, 201-400, and 401-600 : but if there are two threads of one to one of each of the others the sections will be arranged 1-300, 301-450, and 451-600, and so on; and the respective sections of harness cords will be passed through longitudinal sections of the comber-board to correspond. The lay-over, pointed, mixed, or bordered principle of tie-up may be employed, the sectional arrangement in each case enabling each series of warp threads to be separately controlled by its own section of the cards, needles, hooks, and harness. The tie is more conveniently arranged when the card cylinder is over one side of the loom (the London system) than when it is over the front or rear (the Norwich system), but it can be employed with the cylinder in any of the positions.

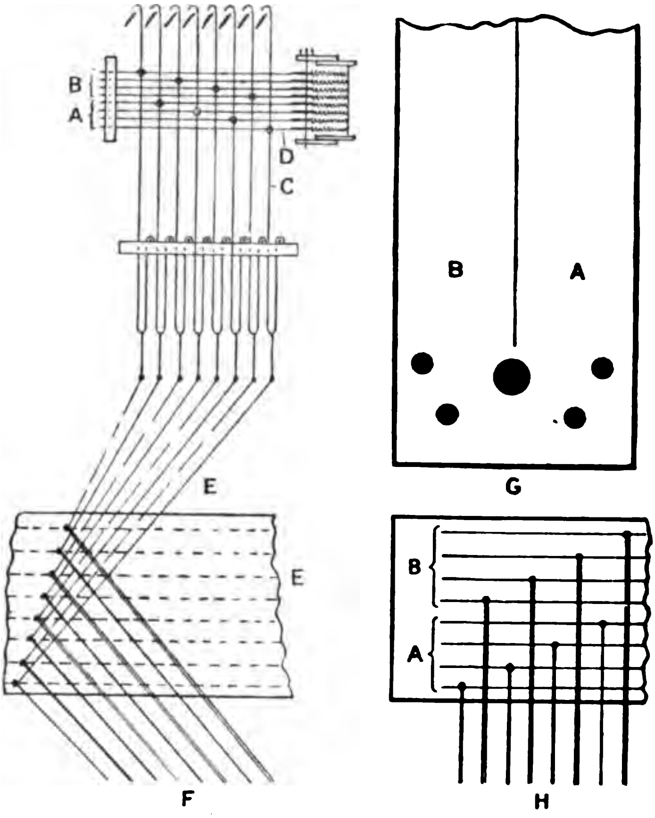

Fig. 184.

Special Connection of Hooks and Needles.—Two methods are illustrated in Fig. 184, either of which may be employed in place of a sectional harness tie for achieving the same results as regards the simplification of the designing. In the method illustrated by the diagram on the left of Fig. 184 the hooks C and needles D are so arranged that the four bottom needles A are connected to the odd hooks, and the four top needles B to the even hooks. The harness tie and the draft of the warp threads, which are represented at E and F respectively, are exactly the same as in an ordinary machine, and it will be seen that the odd threads are controlled by the four bottom needles in each row and the even threads by the four top needles. In this system each card is divided into two longitudinal sections, as shown at G in Fig. 184, and the lifts of the odd threads are cut on the section A which presses against the four bottom needles, and of the even threads on the section B which presses against the four top needles.

Special Draft of the Warp Threads.—This method consists simply of drawing in the warp threads in such a manner that one series passes through the front half A of each short row of harness mails, as represented at H in Fig. 184, and the other series through the back half B. With the needles and hooks and the harness tie arranged in the ordinary manner, the lower half of each row of needles controls one kind of warp, and the upper half the other kind, so that the system of card-cutting is exactly the same as in the previous method. An advantage of the last method is that the usual form of jacquard and harness can be adapted to the special system of designing by drawing in the warp to suit the arrangement of the ends.

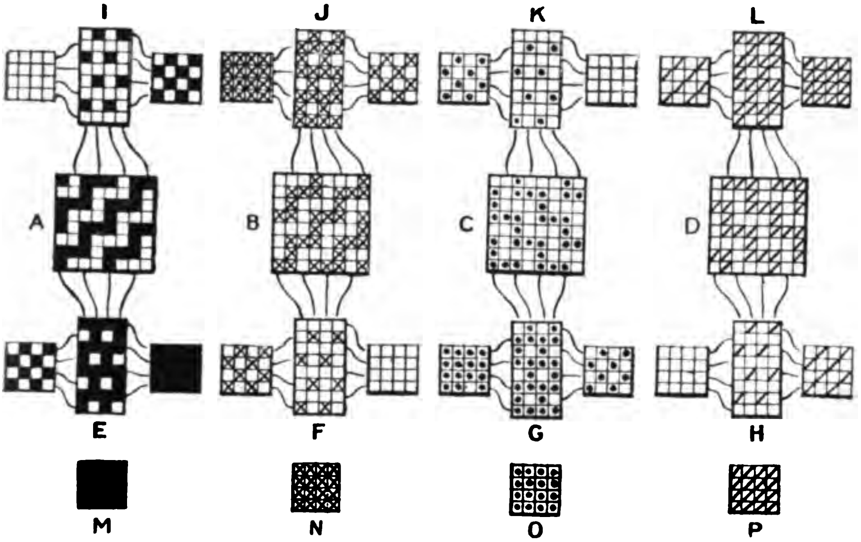

Fig. 185.

In Fig. 184 the arrangement of two kinds of warp in 1-and-1 order, only, is illustrated, but either of the methods may be applied when more than two series of ends are used. Thus, at B in Fig. 445, a warp is shown drafted in five sections to conform with a 5-colour arrangement of the warp threads.

Designing and Card-Cutting for Sectional Arrangements.—The examples given in Fig. 185 show how the painting out of a design is simplified by means of a sectional arrangement, and also illustrate a method of ascertaining the card-cutting particulars by which the desired structural effects will be produced in the cloth. Four different double-plain weaves are given in full at A, B, C, and D (these correspond with the examples similarly lettered in Fig. 176, p. 152), which, it may be assumed, are required to be combined in a design. Two series of ends and picks, in the order of a thread of each alternately, are employed, and a jacquard and harness arrangement in two equal sections, as illustrated in Fig. 183 or Fig. 184, is therefore suitable for the arrangement in the warp. The lifts of the odd ends of the respective double-plain weaves, which are shown separately at E, F, G, and H in Fig. 185, will be cut on one section of the cards, and those of the even ends, which are shown separately at I, J, K, and L on the other section of the cards. On the left of each plan E to L the lifts of the odd picks are shown apart, and on the right the lifts of the even picks. The small plans on the left and right of the examples lettered E to L thus indicate the interweaving of each kind of warp with each kind of weft in the respective weaves A, B, C, and D.

To represent the effects shown at A, B, C, and D a design would be painted solid in four different colours (or in three colours, the fourth effect being represented by the paper), as indicated by the different marks shown at M, N, O, and P in Fig. 185. As there are two series of threads in both warp and weft, each vertical space in the design then corresponds to two ends, and each horizontal space to two picks. Two cards are therefore cut from each horizontal space, and further, the design is cut twice—first, for the section governing the odd ends, and then for the section that governs the even ends. The plans on the left and right of the examples E to L indicate the exact order in which the cards require to be cut from the plans M, N, O, and P, and in order to enable comparisons to be readily made, bracketed references are made to the respective plans in the following list in which the card-cutting particulars are given.

	Section governing odd ends.		Section governing even ends.	
First Card	Cut M plain	(left of E)	Blank M	(left of I)
	Cut N plain	(left of F)	Cut N solid	(left of J)
	Cut O solid	(left of G)	Cut O plain	(left of K)
	Blank P	(left of H)	Cut P plain	(left of L)
Second Card	Cut M solid	(right of E)	Cut M plain	(right of I)
	Blank N	(right of F)	Cut N plain	(right of J)
	Cut O plain	(right of G)	Blank O	(right of K)
	Cut P plain	(right of H)	Cut P solid	(right of L)

If the cards are in longitudinal sections, as shown at G in Fig. 184, for convenience in the card-cutting, the design paper should be ruled in fours vertically for an 8-row machine, and in sixes if the machine is 6-rowed.

As each vertical space of a design corresponds to two or more ends (according to the number of sections) the number of spaces over which a design requires to be extended is only equal to one-half, or one-third, etc., the number of ends in the repeat. Also, as shown in Fig. 185, the arrangement frequently enables the painting-out to be done in such a manner that more than one card can be cut from each horizontal space, so that the design is simplified in length as well as in width; and, further in most cases the weave structure need not be indicated. In a 2-and-1 proportion of the ends, however, it is sometimes found very difficult to cut the smaller section of the cards from the design of the larger section, as two vertical spaces of the latter correspond to one of the former. In such a case it is advisable to paint out both sections separately, one on half as many vertical spaces as the other. Numerous examples are given in the following pages which show the application of the sectional system to different classes of cloths.

METHODS OF INCREASING THE FIGURING CAPACITY OF JACQUARDS

To increase the figuring capacity of a jacquard it is necessary to employ parts which are additional to the ordinary form of mount, and the machine in its modified form may also include a sectional harness tie, a special connection of the hooks and needles, or a special draft of the ends, such as are illustrated in Figs. 183 and 184. The additions to and modifications of the ordinary form of machine are chiefly as follows:—

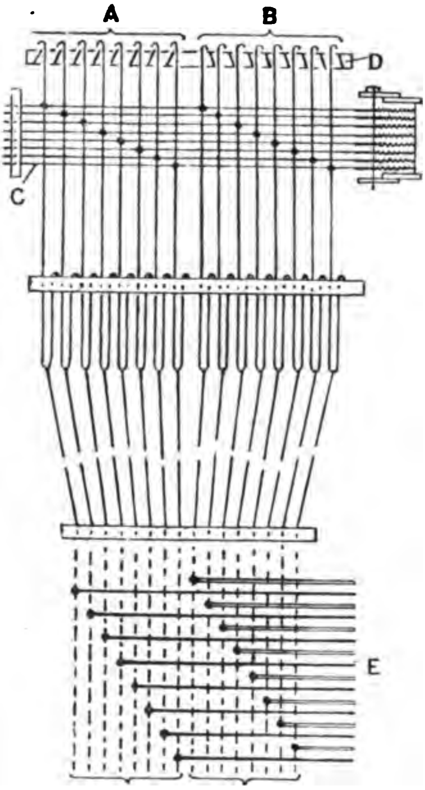

Fig. 186.

(1) Inverted hooks, each of which is connected to the same needle as an ordinary hook.
(2) Ordinary healds combined with a harness.
(3) Pressure healds combined with a harness.
(4) Lifting rods or bars.
(5) Working comber-boards.

In the first modification the ends are controlled entirely by the jacquard; in the second, some of the ends are controlled by the jacquard and others by the healds; while in the third, fourth and fifth systems, the same ends are operated from two sources—viz., by the jacquard for forming the design, and by the additional parts for producing the structure. In some mountings, two or more of the special systems are used in combination. For every needle in the jacquard the cloth may contain two, three, or more consecutive warp threads, and compared with an ordinary mounting, the time occupied in cutting the cards and the weight of card paper required are correspondingly reduced. In addition many of the special modifications are devised so as to enable one card to act for two, three, or more consecutive picks, by which a further great saving in cards and card-cutting is effected. One card is made to act for two or more picks in two ways—viz. (*a*) both the jacquard and the card-cylinder remain stationary for a period during which the additional parts go on working; (*b*) both the jacquard and the additional parts continue in work all the time, but the sneck, which turns the card-cylinder, is put out of action as required so that the same card is pressed against the needles a number of times.

Inverted-hook Jacquards.—This type of machine is used with great advantage in weaving large designs in which two series of ends, arranged in 1-and-1 order, work exactly opposite to each other. As shown in Fig. 186 the jacquard is made with two sets of hooks, A and B, to correspond with the two series of ends. The hooks A have their bent upper ends turned towards the card-cylinder in the ordinary manner, whereas those of B are turned towards the spring-box. One griffe D is employed carrying 16 lifting blades in two sets of 8 blades each, which are inclined towards the hooks that they govern. When in the normal position the hooks A are over their lifting blades, whereas the hooks B are clear of the other set of blades.

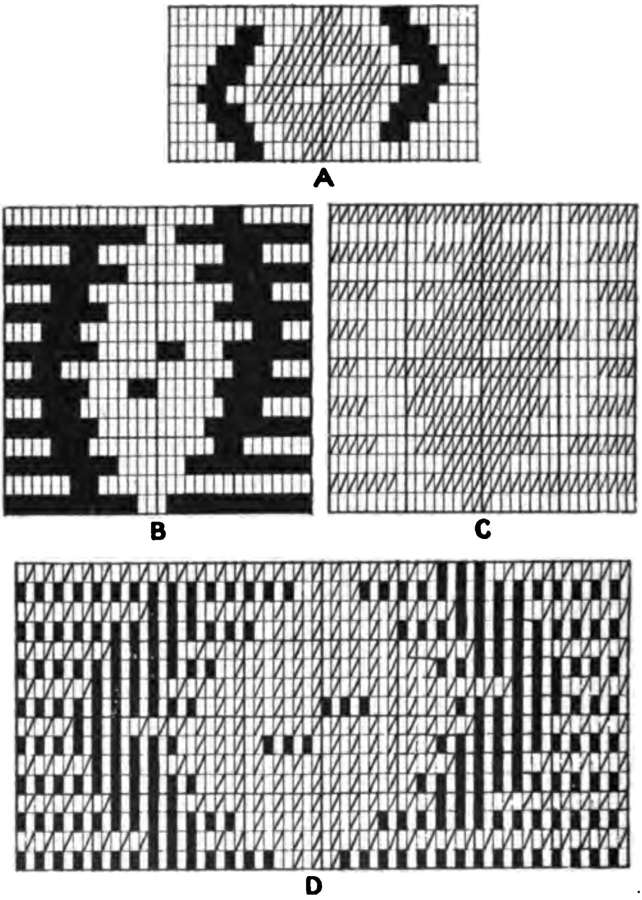

Fig. 187.

The harness cords are tied up in the ordinary manner, but in the warp draft, which is represented at E, one series of ends is drawn upon the harness cords connected to the hooks A, and the other series upon the cords connected to the hooks B. Only one set of needles is used, but each needle is connected to a hook of each set, and thus controls an end of each series. A blank in a card presses a hook A away from the path of its lifting blade, and places the corresponding hook B in position for being raised, while a hole in a card leaves a hook A in position for being lifted, and a hook B out of action. Therefore, where ends of one series are raised, corresponding ends of the other series are left down, and *vice versa.*

A class of fabric for which the arrangement is particularly useful is a reversible warp rib structure, in which a warp figure is produced in two colours upon plain or rib ground on both sides of the cloth. In order to show the special use of an inverted hook jacquard plans are given at A, B, C, and D in Fig. 187, which illustrate the development of a portion of a design from the solid system of marking to the complete reversible rib structure. The figure formed by each colour of warp is painted solid, as shown by the different marks in A, each vertical space of which represents an end of both series, and each horizontal space two picks. Assuming that the dark figure is required to be produced by the ends which are controlled by the ordinary hooks, two cards are cut from each horizontal space, as follows :—

First Card.—Cut all except the marks of the light figure.
Second Card.—Cut only the marks of the dark figure.

B in Fig. 187 shows the lifts that are cut on the cards and are formed by the ordinary hooks, while C, which is exactly opposite to B, shows how the other threads are raised by the inverted hooks. As the ends are drawn through the harness in 1-and-1 order, an end of B is followed by an end of C, and the complete weave is, therefore, as indicated at D.

The inverted hook arrangement, illustrated in Fig. 186, not only enables a very simple method of designing to be employed, but a design is produced that repeats upon twice as many ends as there are needles in the machine. If, however, an increase in the figuring capacity of the jacquard is not desired, one of the sectional arrangements, previously described, will enable the same method of designing to be employed for a reversible warp rib cloth, two cards being cut from each horizontal space ot the design A in Fig. 187, as follows :—

Dark Warp Section.—First card, cut blanks and solid marks ; second card, cut solid marks.

Light Warp Section.—First card, cut diagonal marks ; second card, cut blanks and diagonal marks.

To correspond with the design A in Fig. 187, B then shows the lifts cut on the dark warp section, and C those cut on the light warp section.

Combination of Healds with Harnesses.—When ordinary healds are employed in conjunction with a jacquard harness the threads which they operate in regular order are not passed through the harness mails, but are in addition to the figuring threads. The position of the healds—at the back or front of the harness—is largely a matter of convenience as regards space and depth of shed, but a determining factor is the relative strength of the threads, as the weaker yarn should be operated by the shedding mechanism at the front. Certain of the jacquard hooks may be used in raising the healds, but this prevents a card from acting for more than one pick. Either tappets or a dobby may be employed to work the healds independently of the jacquard (positive shedding motions being most serviceable when the threads controlled by the healds are heavily tensioned), and these motions enable each card to act for any desired number of picks.

A heald-and-harness mount has been previously referred to in connection with extra warp figuring (see Fig. 147), and in the following pages different classes of cloths are illustrated for which the system is employed. One-half, two-thirds, etc., of the warp threads are drawn upon the healds, so that the figuring capacity of the jacquard is increased two or three-fold, etc. The limitation in the arrangement is in the weave of the ends that are operated by the healds, but it will be understood that the ends controlled by the jacquard may be operated as desired.

In the "pressure-harness" system (see Fig. 201) the healds that are used in conjunction with the harness are special in form, and in this case the same ends are drawn through both the harness and the healds, and are operated from the two sources, which results in the weave being limited in both the figure and the ground.

Combinations of Lifting Rods or Bars with Jacquard Machines.—This system enables the harness cords to be operated in longitudinal rows quite independently of the figuring hooks, and at the same time does not prevent the cords from being operated by the jacquard. The method is employed, on the one hand, in order that each needle of the jacquard may control two, three, or more consecutive warp threads, as in the split-harness mounting (described in the following), and the twilling jacquard (see Fig. 204); and, on the other hand, it is used for the purpose of enabling warp threads to be lifted in a definite order without the lifts being cut on the figuring cards, as in certain classes of tapestry (see Fig. 216).

THE SPLIT HARNESS OR SHAFT MONTURE

The split harness or shaft monture (also known as the scale or bannister harness) is used in weaving fabrics which are very finely set in the warp in order to double, treble, or quadruple the width of repeat of the jacquard. Rich silk fabrics, of the non-reversible damask and other types, are frequently woven with only a comparatively few picks per inch, but contain a very large number of ends per inch (400 and upwards in some cases), so that with an ordinary full harness mount a very large machine is required in weaving a wide repeat. In the most common form of split harness, which is illustrated in Fig. 188, an ordinary single-lift jacquard is used, but some distance above the comber-board C each single cord D from the neck cords is connected to two or more double harness cords E each of which is passed through a separate hole in the comber-board. A knot F is tied in each double harness cord, so as to form, above the mail, a loop G which is sufficiently long to allow the proper depth of shed to be made. Also, the comber-board is placed high enough above the knots F to permit the cords to be lifted the proper height without obstruction. The diagram on the left of Fig. 188 represents an 8-row machine, in which the scale is doubled—*i.e.*, two looped harness cords are connected to each single cord D, giving 16 rows of harness cords in the comber-board C. On the right of Fig. 188 three looped harness cords are shown connected do each single cord, which, in an 8-row machine, gives 24 rows in the comber-board.

Operation of the Lifting Rods.—A bannister shaft or rod H (Fig. 188), which is rather longer than the width of the harness, is passed loosely through the loops of each long row of harness cords, so that each rod is capable of lifting one end in every sixteen or every twenty-four, etc., according to the number of rods employed, quite independently of the figuring cards. The arrangement does not prevent the jacquard from lifting the ends in forming the desired figure, but they are necessarily raised by the hooks in groups of two or more to correspond with the scale of the harness. By lifting the rods, the ends that are left down by the jacquard may be raised singly and produce any ground weave (plain, twill, sateen, etc.), which repeats upon a number of ends that is a measure of the number of rods employed. Thus, in the diagram on the left of Fig. 188, the hooks 1 to 4, which are shown raised by the jacquard, lift up the harness mails 1 to 8, but the rods are raised in 1-and-3 order, and lift up one-fourth of the mails—viz., the twelfth and sixteenth—which are left down by the jacquard. Only warp figures can be formed on the surface as the cloth is woven, and a weft figure is therefore produced by weaving the texture wrong side up.

As a general rule, as the cloths do not contain a large number of picks, each card acts for only one pick. The rods H may be operated by means of a dobby, but it is generally found convenient to use a number of specially strong hooks in the jacquard, cords from which are passed through guide holes in the comber-board to near each end of the rods. If the card cylinder is at the back or front of the loom a row of special hooks should be used at both sides of the figuring hooks, in order that the weight will be evenly distributed on the machine. In some cases the needles and hooks, by which the lifting of the rods is governed, are situated a sufficient distance from the figuring needles and hooks to enable them to be operated by a separate small set of cards. This method has the advantage that a design may be woven in different ground weaves simply by changing the small cards.

The split mounting is sometimes arranged with two neck-cords (which pass separately through a board) to each hook, and with the loops, through which the rods are passed, formed in the neck-cords. It is claimed for the arrangement that the rods are situated where there is most space and are out of the way of the weaver. The double neck-cord system is also used in conjunction with a double-lift single-cylinder jacquard machine.

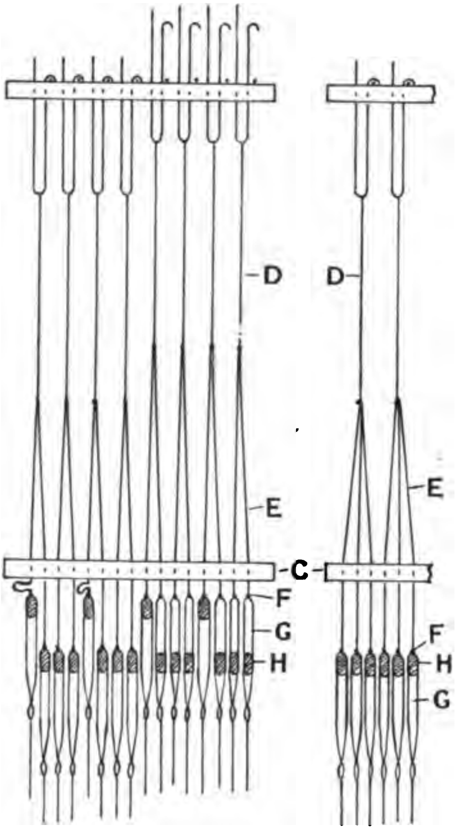

Fig. 188.

System of Designing.—In painting out designs no ground weave requires to be filled in, as this is produced by the lifting of the rods, but the long floats of the figure require to be stopped in the ordinary manner. Thus, A in Fig. 189 illustrates the method of preparing a design for the card-cutting, the particulars of which are:—Cut marks. Assuming that the rods are raised in 1-and-3 twill order, as indicated at B, the full design will be as shown at C in a double-scale mounting, and as represented at D in a treble-scale mounting. At the edge of the figure each step of one end in A corresponds to a step of two ends in C, and three ends in D;

while, similarly, each single binding point in the figure represents two ends in C and three ends in D. In the ground, however, the ends are operated singly, as shown by the dots.

It is necessary to take into account that the lifts produced by the rods are liable to occur where ends have been left down by the jacquard for the purpose of binding the figure. The dots inside the figure in B and C indicate such lifts, and it will be seen that the binding of a warp float is neutralised at each place.

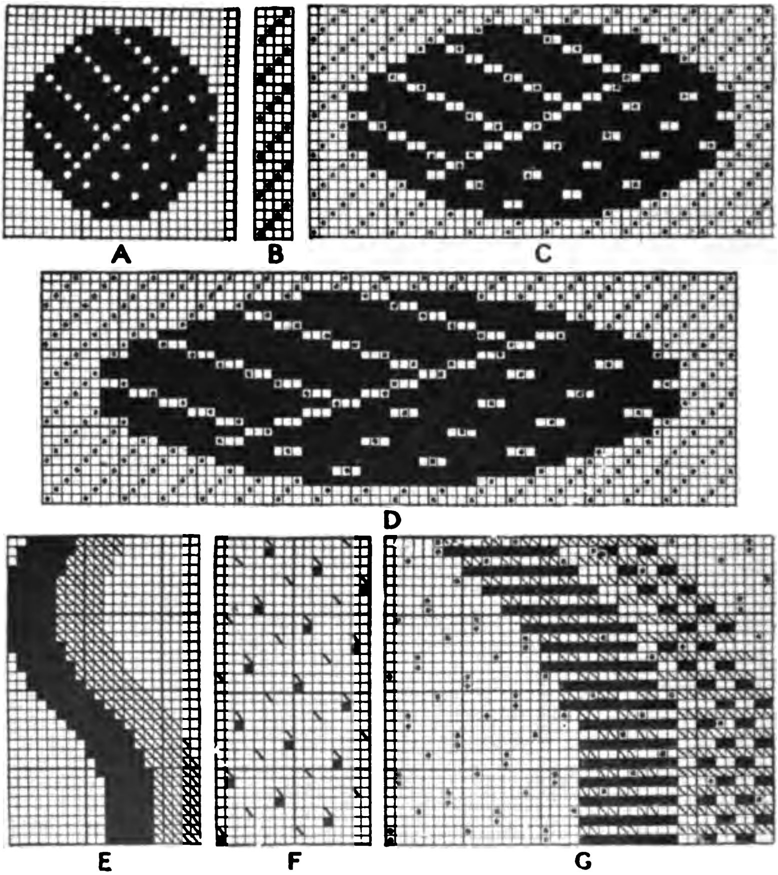

Fig. 189.

In fine cloths which have a weft figure upon a warp sateen ground (produced by weaving the cloths wrong side up), the defective warp float is on the wrong side, and the fault is considered of such little importance that it is generally ignored in painting out designs. However, the defect can usually be avoided by inserting each binding place in the figure upon two consecutive vertical spaces, but this is liable to break up the figuring weft floats on the right side of the cloth, particularly in sateen binding weaves, in such a manner that the remedy is worse than the defect.

The split harness system greatly simplifies the processes of drafting and cutting designs, and there is scarcely any limit to the diversity of weave development that can be obtained in a design, nor to the variety of ground weave that may be used. The outline and binding lines of a figure, however, are rather steppy, but the figure shows up very bold and clear upon the fine ground effect that is generally formed. The system is readily applied to elaborately-figured multiple-weft fabrics, and E in Fig. 189 illustrates the method of designing a figure in two wefts, which are inserted in pick-and-pick order. Two cards are cut from each horizontal space of E as follows :—

First Card.—Cut the marks of the first colour and those of the second colour plain.

Second Card.—Cut the marks of the second colour and those of the first colour plain.

Assuming that the scale of the harness is doubled, and that the rods are raised in the order indicated at F (by which one of the wefts is interwoven in 8-sateen and the other in 16-sateen order in the ground), the full weave to correspond with the lower portion of E will be as indicated at G. It will be seen that the plain cutting of the figure produces a 2-and-2 weft rib weave under each kind of weft float. This example may be compared with that given in Fig. 132 (p. 121).

WORKING COMBER-BOARDS

In this system each harness cord is knotted in such a position that the knot rests on the comber-board when the harness mail is at the bottom line of the shed. The knots do not prevent the cords from being raised individually by the jacquard in the ordinary manner, whereas by lifting the comber-board all the cords, whose knots rest upon it, are raised together. In the manufacture of Brussels and Wilton carpets (see Fig. 445) only one board is employed, but for Marseilles quilts (see Figs. 23C and 231) and satin quilts (Fig. 234) the board is in two longitudinal sections, and for Kidderminster carpets (Fig. 218) in four longitudinal sections, which enable the ends to be raised in groups separately.

In weaving Marseilles and satin quilts, working comber-boards are used in conjunction with ordinary healds, and in Fig. 190 a form of the mounting (as made by Messrs. Robert Hall & Sons) is illustrated. There are two knotted comber-boards A, and two healds B (one of each is shown partly raised), which are operated by means of four tappets C. Cords D, straps E, levers F, and cords G, connect the tappets with the top of the comber-boards and healds, while through levers H similar connections are made with the bottom staves of the healds. Spiral springs I are employed to assist the downward movement of the comber-boards. The tappets C are rotated at the proper speed by the wheel J on the end of the crank shaft gearing into the wheel K connected to the tappets. The jacquard is operated once in every group of picks by means of a positive tappet L, which is driven by a wheel on the crank shaft. Through connecting levers the vertical rod M, which is connected to the jacquard griffe, is made to fall and rise and remain stationary as required, by the tappet L.

Special forms of jacquard and harness mounts are further described and illustrated in the following pages, along with the particular classes of cloths for which they are used. They include the book-harness mounting, pressure harness, self-

twilling jacquard, tapestry mounting, double-plain cloth jacquard, special gauze jacquard, Madras gauze mounting, and pile carpet jacquards, and in addition lappet and swivel mechanisms are dealt with.

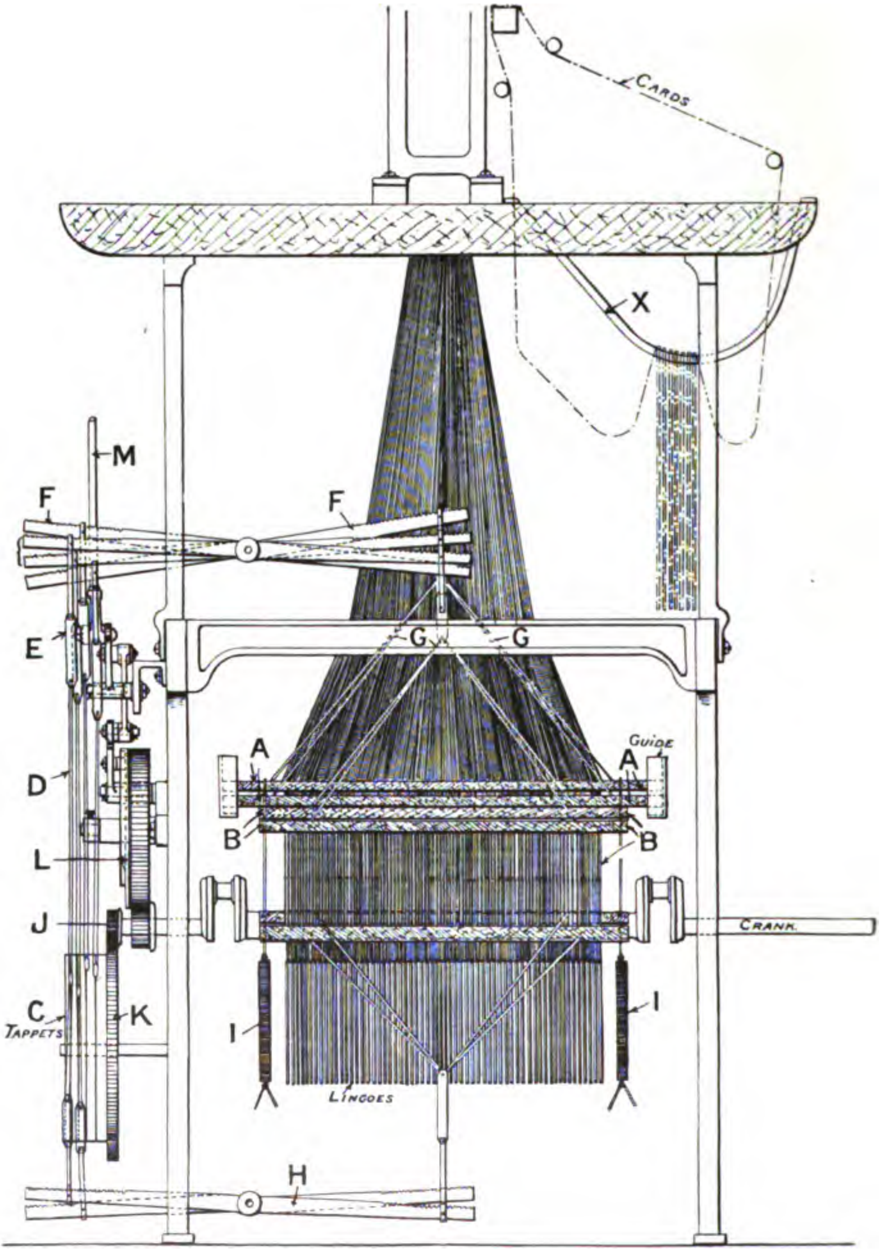

Fig. 190.

CHAPTER IX

FIGURED MUSLIN AND DAMASK FABRICS

Figured Muslin Fabrics. **Figured Book Muslin Fabrics**—System of Loom Mounting and Structure of the Cloth—Features in Painting-out Designs—Ground Weave Variation—Introduction of Ground-Weft Cords—Weaving Particulars of Book-Muslins—Book-Muslin Loom. **Damask Fabrics**—Reversible and Non-Reversible Damasks—*The Pressure Harness*—Form of the Healds—Operation of the Harness and Healds—Method of Designing—*The Self-Twilling Jacquard*—Arrangement of Needles, Hooks, and Lifting Bars—Operation of Twilling Needles—Proportions of Hooks to Needles—Operation of Card Cylinder—Changing the Capacity and Sett—System of Designing—Production of Diversity of Effect.

FIGURED MUSLIN FABRICS

An essential feature of a figured muslin fabric is the formation of a light semi-transparent foundation texture, and ground yarns are used which range in fineness from 70's to 120's cotton in warp and weft. The ground texture is most frequently white or cream, and upon it an opaque figure is produced by means of extra threads, which may be either white or coloured. The extra threads are only retained in the cloth where the figure is formed, and when all the yarns are white the design is chiefly apparent because of the difference in density between the figure and the ground. The cloths are woven in the thread or full-harness system by inserting the figuring threads, as extra weft or warp, in the ordinary manner; and in Fig. 116 (p. 112) an illustration of an extra weft style is given; Fig. 156 (p. 139) and Fig. 161 (p. 142) represent extra warp muslin fabrics; while Fig. 173 (p. 149) shows figuring with both extra weft and extra warp. Special methods of producing particular forms of the cloth also are employed, which include Madras, lappet, and swivel weaving (subsequently described and illustrated under their respective titles), and an important class, termed book-harness muslins, is described and illustrated in the following:—

FIGURED BOOK MUSLIN FABRICS

In the "book-harness" muslin structure a light plain foundation texture is ornamented with extra weft, in the manner represented in Fig. 191, which shows the appearance of a typical fabric as viewed from opposite sides. The extra weft is thick and soft spun, and in the figured portions of a cloth it is, as a rule, inserted in 2-and-2 order with the plain ground picks. As the cloth is woven, the figuring picks are floated loosely on the surface between the parts of the ornament that are detached from each other horizontally; but in the finishing process the loose floats are cut away so that an opaque figure appears upon a semi-transparent ground. The cloths are practically reversible, but, as shown in Fig. 191, the uncut side—represented in the lower portion of the figure—is neater in appearance than the cut side, which is shown in the upper portion, as on the latter side the severed ends of the figuring picks impart a rough edge to the figure. The textures are used as window curtains, and in small designs for skirtings and blouse and dress fabrics.

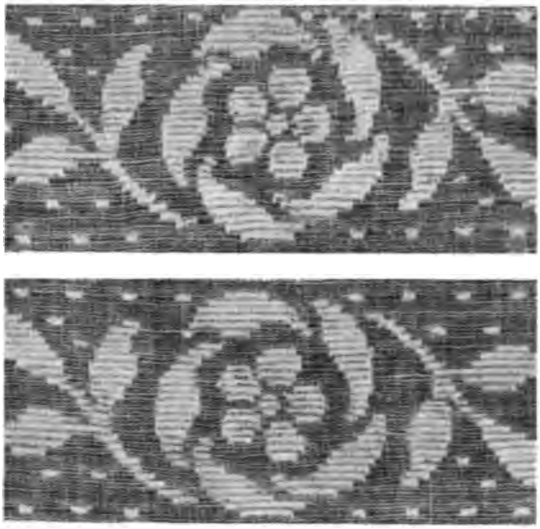

Fig 191

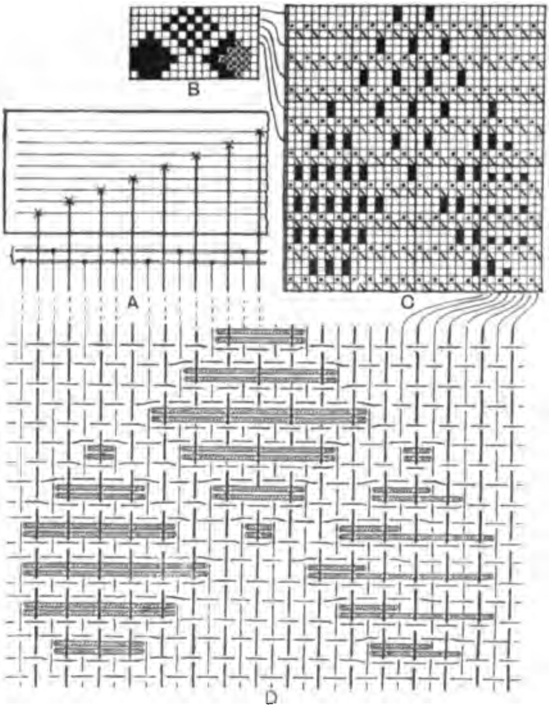

Fig. 192.

System of Loom Mounting and Structure of the Cloth.—In Fig. 192, A shows the heald-and-harness draft that is commonly used, and B a sectional design which is represented in full at C, whilst D illustrates the interlacing of the threads to correspond with C, as viewed from the cut side (the face side as the cloth is woven). The odd warp threads are drawn upon two healds (which work together as one), and the even threads upon the harness, the arrangement enabling designs to be woven which repeat upon twice as many threads as there are hooks of the jacquard tied up. By comparison it will be seen that each horizontal space of the plan B in Fig. 192 is equivalent to four horizontal spaces of C, and each vertical space of B to two vertical spaces of C. Further, a comparison of the draft A with the flat view D will show that the plain foundation results from lifting the full harness on the first pick of each pair of ground picks (represented by the diagonal marks in C), and the two healds on the second pick (represented by the dots in C). On the extra picks the healds are left down, but the harness is raised where figure is required to be formed—that is, the marks in the plan B in Fig. 192 indicate warp up.

In the most usual structure of the figure the extra picks float over only one end at a place on both sides of the cloth, as shown in the spot on the left of C and D in Fig. 192. On the uncut side of a cloth a longer float than over one end cannot be produced, because alternate ends are depressed by the healds on the figuring picks. On the cut side the harness ends may be operated in any desired order by the jacquard, but if long figuring floats are made they are liable to be cut away in the shearing process along with the floats which extend between the figures. It is, therefore, customary in a figure to leave down not more than one harness end at a place, which gives a float of three ends in the cloth on the cut side, as shown in the central spot in C and D, Fig. 192. The weave development of a figure is thus limited to floats of one and three in the cloth, but a further variation of the structure is made by interweaving both figuring picks of a pair in one portion and only one pick in another portion, as shown in the spot on the right of C and D in Fig. 192. An effect is obtained which, being between the semi-transparent ground and the opaque figure, is useful in shading a design; and the card-cutting particulars of the plan B to obtain the result are: Cut the solid marks on both figuring picks of a pair, and the crosses only on the odd picks.

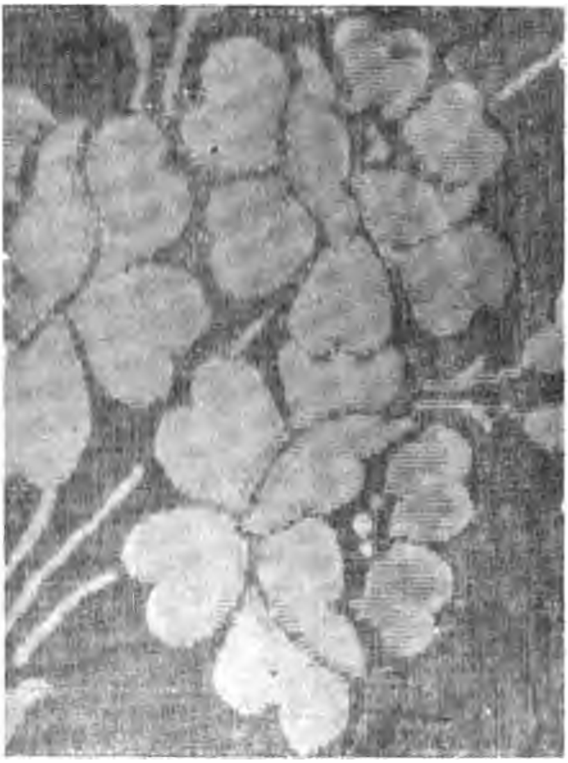

Fig. 193.

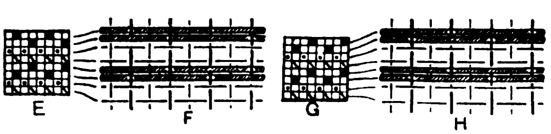

Fig. 194.

The three methods of interweaving the figuring picks, illustrated at C and D in Fig. 192, are largely used, but as both picks of a pair are inserted into the same shed, adjacent pairs are distinctly separated from each other by the plain ground picks. The running of the figuring picks in pairs is clearly shown in Fig. 191, and, generally, this is considered a feature of the structure. Sometimes, however, this formation is avoided as much as possible, and in Fig. 193 a fabric is represented in which a fuller and more solid figure is obtained by floating the picks of each pair alternately in 3-and-1 order. The 3-and-1 floats may be arranged as shown at E and F in Fig. 194, in which the last figuring pick of one pair is in the same shed as the first pick of the next pair, or as indicated at G and H, in which they run continuously in alternate order.

Features in Painting-out Designs.—The plan given at K in Fig. 195, which corresponds with a portion of the design represented in Fig. 193, will serve to illustrate several features in the painting-out of designs for these fabrics. It is a rule to separate two portions of figure—between which the light ground texture is required to show distinctly—by at least two horizontal spaces of the design paper. Otherwise the weft floats between the parts will not be long enough to be engaged by the shears, and by being retained in the cloth will make the two portions of

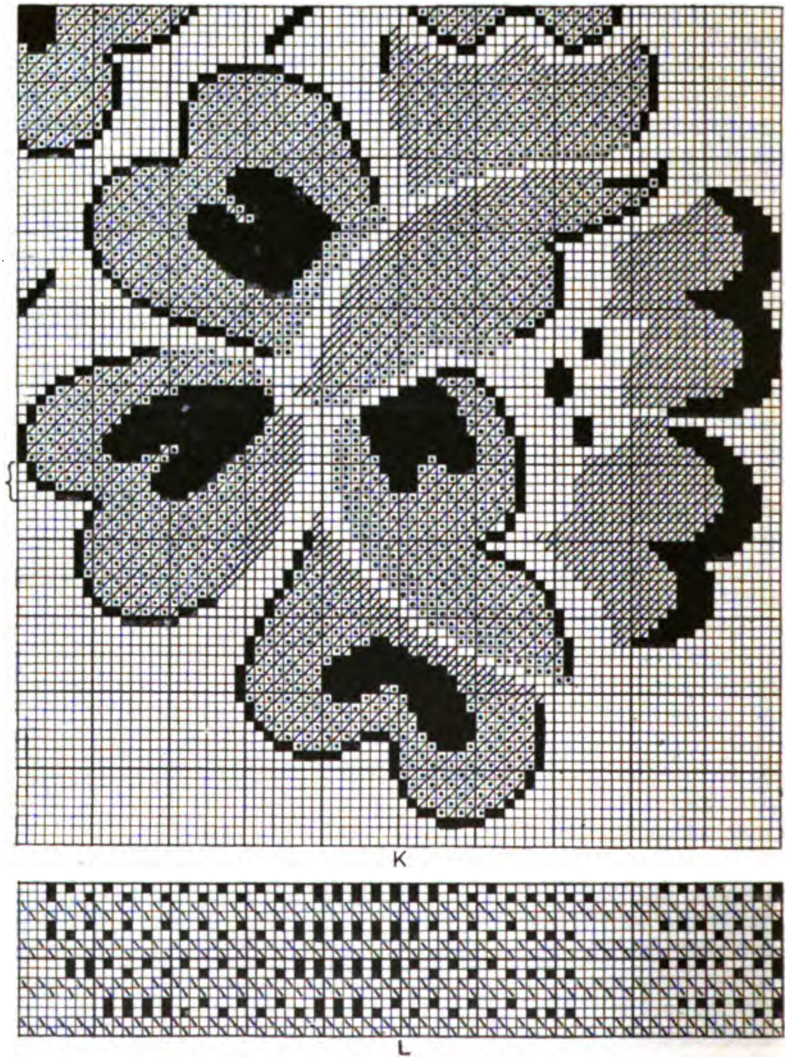

Fig. 195.

figure appear to join up. Frequently, in the finer set cloths three consecutive spaces are left blank horizontally, in order to ensure that the light ground texture will show clearly between the separate parts of a figure. The card-cutting particulars of the design K are :—First figuring card of each pair—cut the full squares and the diagonal strokes ; second figuring card—cut the full squares and the dots. In the bulk of the figure the diagonal marks and dots are inserted in alternate order, which, in the foregoing order of cutting, results in 3-and-1 floats being formed alternately, as shown at F in Fig. 194 ; while by reversing the cards of alternate pairs the structure represented at H in Fig. 194 will be produced. Floats of one thread only are made in the remaining portions of the design —by both figuring picks where the solid marks are indicated ; by the odd figuring picks where the diagonal marks only are shown ; and by the even figuring picks where only the dots are inserted. The two last orders of marking are for shading the figure, and it will be seen that where two shaded effects are made close together, one is formed by the odd picks (the diagonal marks) and the other by the even picks (the dots). The object of this is to get as great a length of float as possible between the separate parts of the figure, so that the floats will be effectively cut away ; while the arrangement also tends to equalise the lifts of the harness threads. In order that comparisons may be made, the complete weave of the picks 37 to 40 (indicated by the bracket at the side of K) and the ends 1 to 40 is given at L in Fig. 195, assuming that the preceding order of cutting is employed.

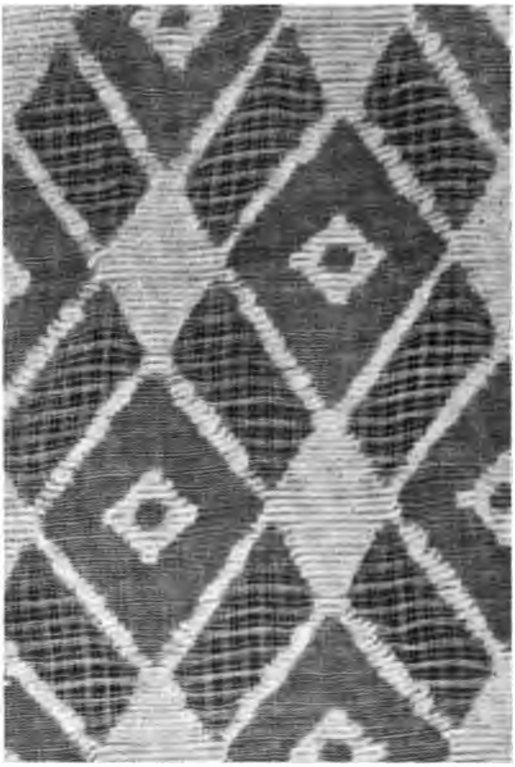

Fig. 196.

Ground Weave Variation.—In the cloth shown in Fig. 196 a useful variation ot the plain ground texture is illustrated in the form of a 5-and-1 imitation gauze weave, which is used in these fabrics to a considerable extent. The corresponding complete card-cutting plan is given at M in Fig. 197 ; the full squares are cut on the figuring picks (two cards alike from each horizontal space), and the diagonal marks on the cards which are employed in raising the healds. The complete weave of the picks 12, 13, and 14 (indicated by a bracket), and the ends 1 to 25, is given at N, while the plan O, which corresponds with the last six ends of N, with the figuring picks omitted, shows the imitation gauze weave that is formed in the ground.

Introduction of Ground-Weft Cords.—The fabric represented in Fig. 198 illustrates a style in which thick cord ends are used to supplement the effect produced by the extra weft. The cord ends are interwoven in the cloth in the space between two massive portions of figure which occur at intervals, but where the massive figures are formed they are floated loosely on the surface (the cut side) and are afterwards sheared off. The extra weft is introduced only to a small extent where the cord ends are woven in, but the latter give the cloth the appearance of having the extra weft inserted continuously. The complete design of the fabric—the last sixteen picks enclosed by the bracket Q being repeated five times—is given in Fig. 199, in which the crosses represent the cord ends The card-cutting particulars are :—Cut the full squares and the crosses on the figuring picks, and the crosses on the cards that are used for the heald sheds. In order to show the effect of the cutting, the full weave of the four picks and eight ends, with which it is shown connected, is inset at P. The cord ends are extra (there are three ends per split at each place), and where each is interwoven it works along with the accompanying harness end. Previous to the shearing process the cord ends are cut by hand by means of a knife which is run across the cloth at the places where the ends are floated, the free threads then being sheared off at the same time as the floating picks.

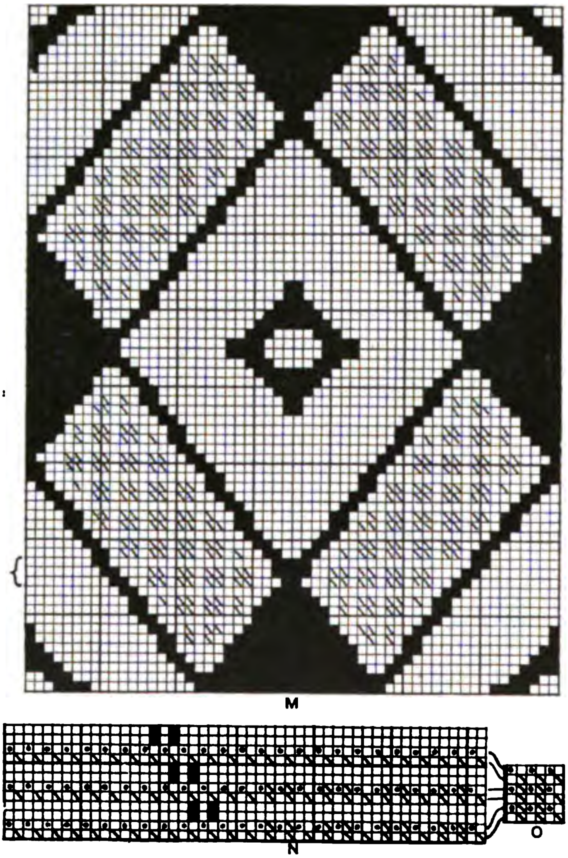

Fig. 197.

Weaving Particulars of Book Muslins.—The number of ends per inch with which the cloths are woven usually ranges from 48 to 60, and the number of ground picks from 40 to 56 ; the warp yarns range from 60's to 80's cotton, and the ground weft yarns from 70's to 100's cotton ; while from 16's to 20's soft spun figuring weft is used. The average number of figuring picks per inch varies according to the order in which they are inserted, and the cloths are classed as "full cover," in which the extra picks are inserted continuously with the ground picks, or one-half, two-thirds, two-fifths cover, etc., in which the extra picks are inserted intermittently. The proportion of the cover can be obtained by finding the number of horizontal spaces of the design upon which the extra figuring picks are indicated in relation to the total number of horizontal spaces in the repeat. Thus, in Fig. 199 there are 50 figuring spaces and six blank spaces, then two figuring spaces and six blank spaces repeated eleven times, giving a total of 72 figuring spaces in a repeat of 144 spaces, which is equal to a "half-cover." The design paper should be ruled in the same proportion as the ends per unit space are to the ground picks. Thus, for a cloth that counts 63 ends × 55 ground picks per inch 8 × 7 paper is suitable. In most cases the yarns are white, but occasionally a coloured figure is made upon a white ground, and sometimes, by chintzing, a figure is woven in white and a colour, or in two colours.

Book-Muslin Loom.—Usually, the book-muslin loom is made with a very simple box motion, two boxes being provided at one side which are brought into operation in turn by means of special hooks in the jacquard. The extra picks are not woven into the selvages, but are bound at each side by a strong catch cord which is raised by a special hook on both ground picks and one of the extra picks. A special hook is also set aside for bringing the healds into operation. If an ordinary form of jacquard is employed, four cards are required for each group of four picks—viz., a fully punched card for the full harness ground shed; a blank card for the heald shed (except that holes are cut for operating the healds and the boxes, and to lift certain harness ends when a special effect is woven); and two figuring cards for the two extra picks. Frequently, however, a card-saving mechanism is applied, which, in order that the formation of the different effects previously described will not be interfered with, is devised so as to dispense only with the cards for the full harness ground sheds. One-fourth of the cards are saved in the figured portions of the cloth, and one-half where no extra weft is inserted—that is, one card is saved to correspond with each horizontal space of a design.

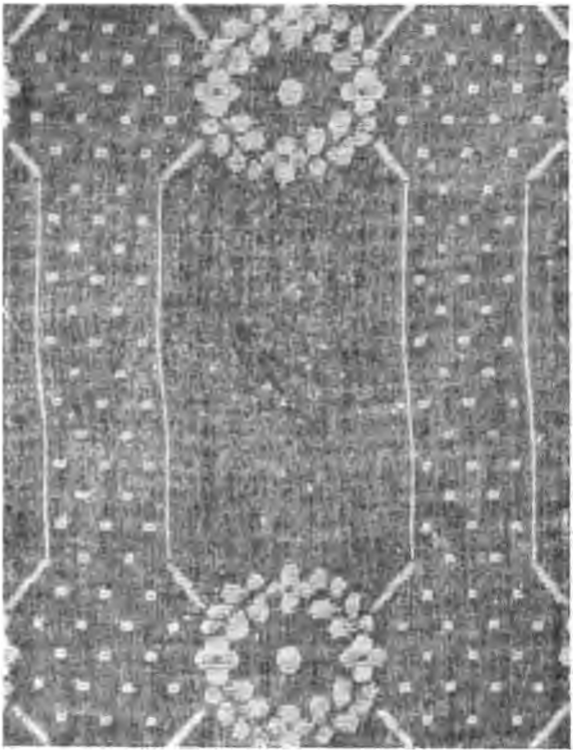

Fig. 198.

In one system, in which a double-lift, single-cylinder jacquard is used, the card cylinder is brought into operation only when a certain hook, which is set aside for the purpose, has been raised on the preceding pick. The card which precedes the full harness lift (the first ground pick of each pair) always causes the particular hook to be left down, so that on the full harness lift the card cylinder is left away

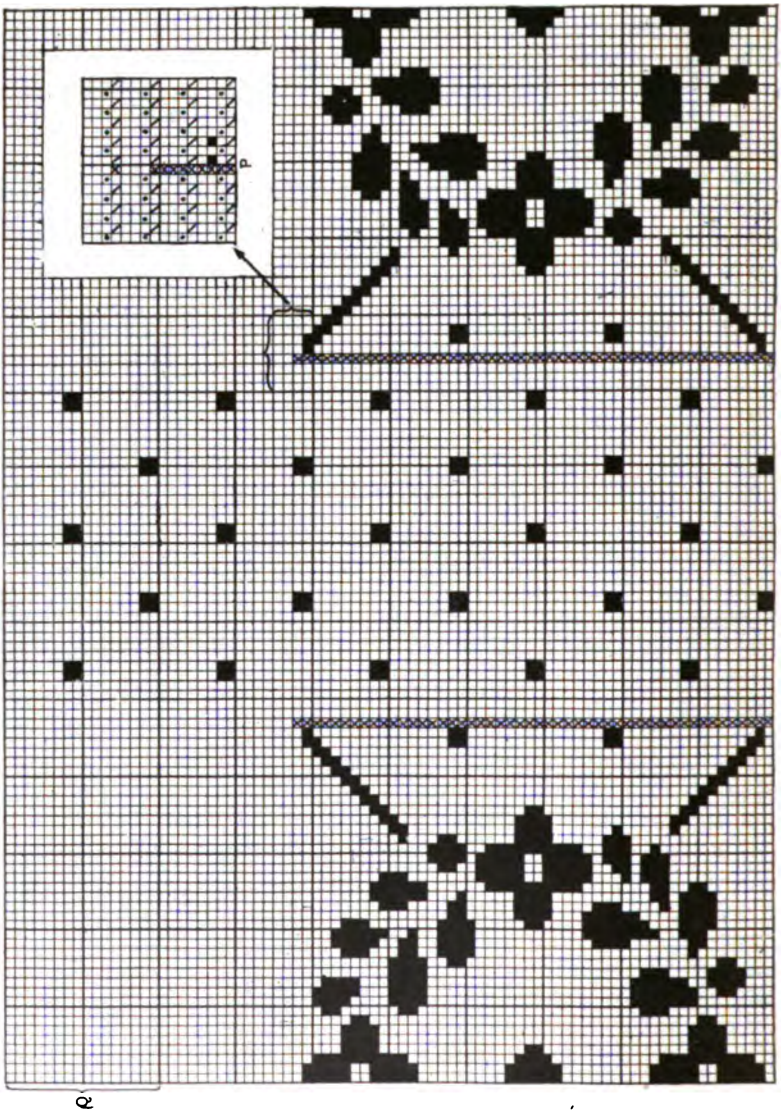

Fig 199

from the needles, and thus produces the same result as a fully punched card. On the latter lift the special hook is automatically raised, so that the card cylinder is brought into action on the following pick. In the figured portion of a cloth the cylinder is put out of action by the second figuring pick of each pair, and where no extra weft is inserted, by each card that is used for a heald shed. In order that the full harness lift will not interfere with the position of the boxes, by raising the hooks by which the boxes are controlled, each of these hooks is single, and is operated by the opposite griffe to that which rises on the full harness shed.

DAMASK FABRICS

Reversible and Non-Reversible Damasks.—In a true damask figured fabric, a weft sateen figure is formed upon a warp sateen ground, or *vice versa*, and the structure is described as reversible. The term damask, however, is also applied to cloths in which the figured portions are developed in diverse ways upon a sateen ground, the texture being then known as a one-sided damask. Fig. 200 illustrates a method of developing a figure as a one-sided damask upon 5-sateen ground, Cotton and linen damasks are used in the white state for table napery; cotton or linen warps are crossed with worsted weft, and in the dyed condition the cloths (termed union-damask) are used for table-cloths, hangings, etc., while fine silk damasks are used for a variety of purposes.

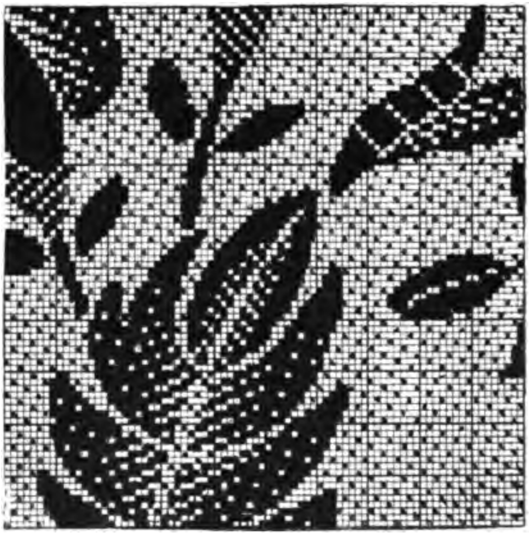

Fig. 200.

Designs in which diverse weaves are employed in the figure are woven in ordinary or full-harness mountings. Small reversible damask designs are also frequently woven in a similar manner, in which case it is necessary for the binding weaves of the figure and ground to be cut upon the cards since each end in the repeat is controlled by a separate needle and a card used for each pick. Very large designs, which are extensively woven in the finer qualities of table-cloths, napkins, etc., require for economical and practical reasons the use of special machines, and of these there are two chief types—viz., the Pressure Harness, and the Twilling Jacquard. The objects of each arrangement are to enable each needle of the jacquard to control two or more consecutive ends, and each card to act for two or more successive picks; and to simplify and reduce the cost of painting out designs and card-cutting. In each mounting the ends are controlled both by and independently of the figuring cards.

The Pressure Harness.—The jacquard is generally an ordinary single-lift machine in which each needle controls one hook and one harness cord in the repeat, but two or more ends are drawn through each harness mail. In order to prevent the ends from twisting round each other "decked" harness mails are used, each mail being provided with several eyes through which the ends are drawn individually. In Fig. 201, A and B show two forms of decked mails, the former being constructed to take three, and the latter four ends (or a less number). The number of ends per mail is varied according to the ratio in which the capacity of the jacquard is required to be increased and to suit the sett of the cloth to be woven, but it is convenient to arrange them in such an order that the number to each short row of the harness is a multiple of the number of threads in the repeat of the binding weaves. Thus, for 8-sateen binding weaves a 12-row machine may be arranged with two or four ends per mail, giving respectively, 24 ends or three repeats, and 48 ends or six repeats of the weaves to each row of harness mails. If 32 ends are required per row, the ends may be arranged in the 12 harness mails in the order of 3, 3, 2 for four times, and for 40 ends per row in the order of 4, 3, 3 for four times. For 5-sateen binding weaves an arrangement of eleven 2's and one 3, giving 25 ends per row of twelve needles, is suitable, while 2 and 3 alternately for four times will give 20 ends per row in an 8-row machine. The last order of arrangement is illustrated in Fig. 201.

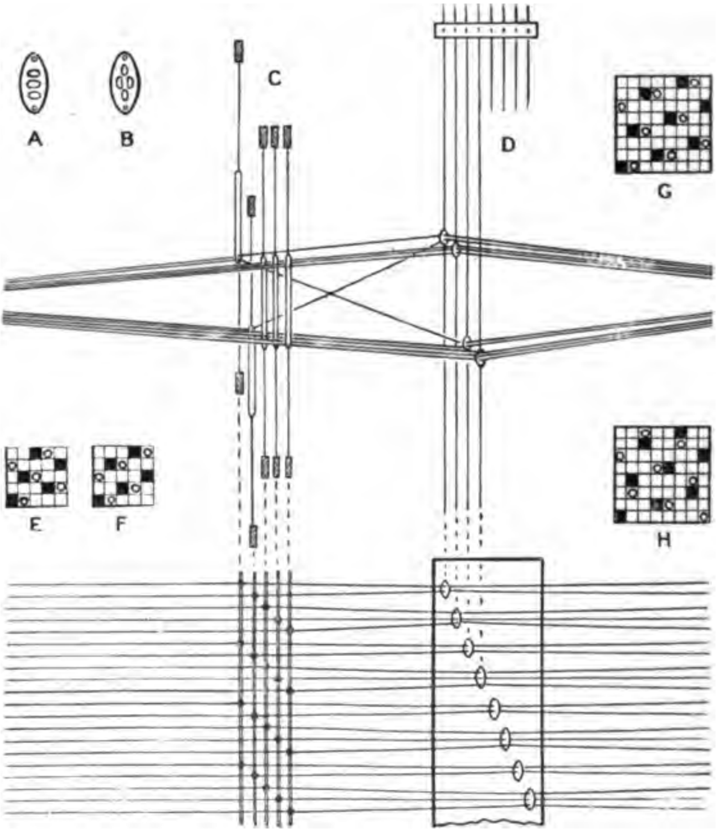

Fig. 201.

Form of the Healds.—Some distance in front of the jacquard harness as many special healds are placed as there are threads in the repeat of the binding weaves—

eight if 8-sateen weaves are employed, and five in the case of 5-sateen weaves. In Fig. 201 five healds, C, are represented in front of an 8-rowed harness, D; the upper portion of the diagram illustrates the formation of the shed, while the lower portion shows the draft. It will be seen that the ends are drawn through the harness mails in groups of 2 and 3 alternately, and then singly upon the healds, each of which is provided with eyes that are about 2½ inches long.

Operation of the Harness and Healds.—The jacquard lifts the threads in groups —thus, in the upper portion of Fig. 201 five threads are shown raised by the harness cords 1 and 2, and five depressed by the cords 3 and 4; and the jacquard remains stationary and retains the threads in these positions for as many consecutive picks as required. On each succeeding pick, however, one heald is raised and another depressed in turn, while the remainder are in the centre. As shown in the diagram the long eyes of the healds permit the ends, that pass through the healds in the centre, to retain the position in which they are placed by the jacquard; but of the ends that are raised by the jacquard the depressed heald draws down one end to each repeat of the binding weave, and similarly, of the ends that are left down by the jacquard the lifted heald raises one end to each repeat of the binding weave. The jacquard thus lifts the ends in solid groups in accordance with the form of design that is required, while the healds operate them singly and effect the binding of both the figure and the ground.

E in Fig. 201 shows the weaving plan of the healds for 5-sateen binding weaves, the solid marks representing healds raised, and the circles healds depressed. F is similar to E, except that the sateen runs in the opposite direction. In both weaves the sateen runs in the same direction in both figure and ground, which cannot be avoided in the 5-thread weave. G in Fig. 201 shows the plan of the 8-sateen binding weaves, in which the sateen runs in the same direction in both figure and ground. This is the usual arrangement, but as shown at H, in the 8-sateen weave the order of lifting may be in the reverse direction to the order of depressing the healds, so that the figure and ground may be twilled in opposite directions. The most convenient method of operating the healds in power weaving is by means of positive box tappets, which are placed at the side of the loom.

One-fifth or one-eighth of the ends (according to the number of healds) is moved by the healds to the opposite line of the shed to that in which they are placed by the jacquard, so that at each pick a proportion of the warp is under greater strain than the remainder. This is shown in the upper portion of Fig. 201. In order that the strain will be as little as possible, shallow shuttles, which require only a small shed opening, are used; the harness is placed about the same distance back from the healds as the latter are from the fell of the cloth, and a long stretch of warp is provided behind the harness. An advantage of the pressure system is that the number of ends per unit space can be changed simply by varying the number drawn through each harness mail, and using healds of corresponding fineness. The number of picks to each card can also be varied, and it is therefore possible, in the same machine, to use a set of cards in weaving a design in different qualities of cloth.

Method of Designing.—A simple example of a damask fabric is represented in Fig. 202, while K in Fig. 203, which shows one-fourth of the repeat of the figure, illustrates the method of painting out a design. The figure is painted solid, and no binding weave is indicated upon either the figure or the ground. If five ends are drawn through two harness mails, as represented in Fig. 201, and the binding weaves are as shown at E, while each card acts for three picks, the complete weave in the cloth of the first 20 ends and 16 picks of K will be as indicated at L in Fig. 203. Taking the marks to indicate warp, the blanks in the figure represent ends that are raised by the harness and lowered by a depressed heald, and the crosses in the ground, ends that are left down by the harness and lifted by a raised heald. In comparison with a full harness mount the number of cards required for the foregoing arrangement is in the proportion of $\left(\frac{2\text{ mails}}{5\text{ ends}} \times \frac{1\text{ card}}{3\text{ picks}}\right)$ to 1, or as 2 to 15; which gives a saving in cards of $86\frac{2}{3}$ per cent.

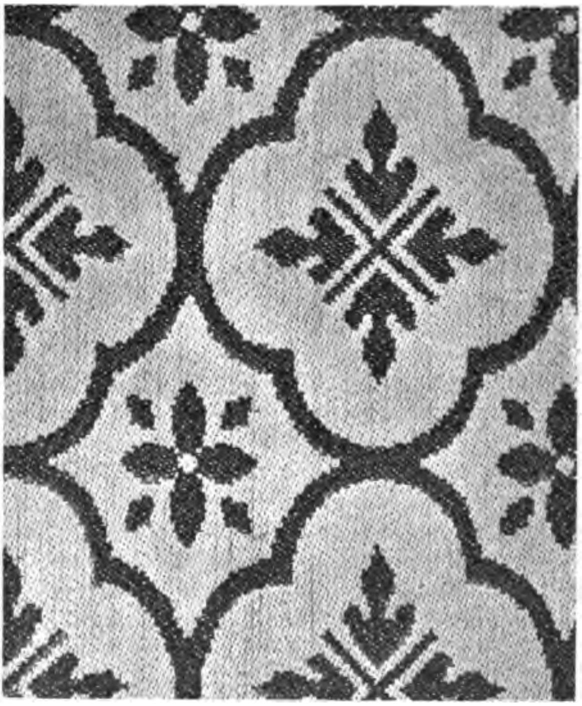

Fig. 202.

M in Fig. 203 shows the complete weave of the picks 1 to 16 of K assuming that eight healds are operated in the order indicated at G in Fig. 201, and that two ends are drawn through each harness mail, and each card acts for two picks. In this case a saving of 75 per cent. in cards is effected.

A fault of the pressure system, which will be readily seen by comparing L and M with K in Fig. 203, is that the figure runs in steps at the edges, so that it has a somewhat broken and rough outline. The steppy edge of the figure is also clearly apparent in Fig. 202. In fine cloths the defect is not very pronounced. but it increases in prominence in proportion to the reduction in fineness of a cloth and the increase in the number of ends per mail and picks per card.

The Self-Twilling Jacquard.—In power weaving this type of machine has very largely superseded the pressure harness system which is more particularly adapted to hand-loom work. The increase in the capacity of a self-twilling machine is obtained by connecting each needle to two or more consecutive hooks (instead of drawing two or more ends through each harness mail). Each end in the repeat of a design is controlled by a separate hook, and one end only is drawn through each harness mail; the shed is formed in the ordinary manner without undue strain upon the warp threads.

Arrangement of Needles, Hooks, and Lifting Bars. — The principle of the machine is illustrated in Fig. 204, in which the diagram X shows the connection in a 12 row machine (which is the usual size) of two figuring hooks A to each needle B, the capacity of the machine in this case being doubled. Each figuring hook A is made at the lower end in the form of a loop C which is rather longer than the depth of the shed, and when in their lowest position the hooks rest upon oblong bars D, one of which extends right through each long row of hooks. The bars D offer no obstruction to the lifting of the figuring hooks by the jacquard. At each side of the figuring hooks, a special row of strong twilling hooks E—shown in diagram Y, Fig. 204—is provided, each of which form a loop F round a bar D, so that the

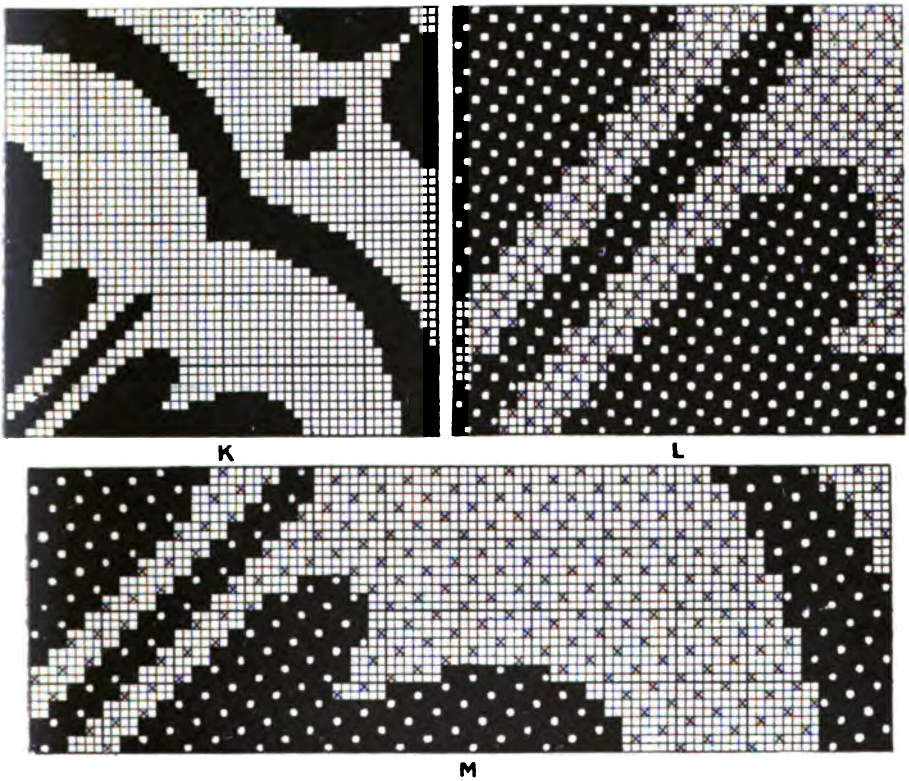

Fig. 203.

bars are supported at both ends. A plate G at each side serves as a rest for the twilling hooks E when the latter are in their lowest position, and the plates are

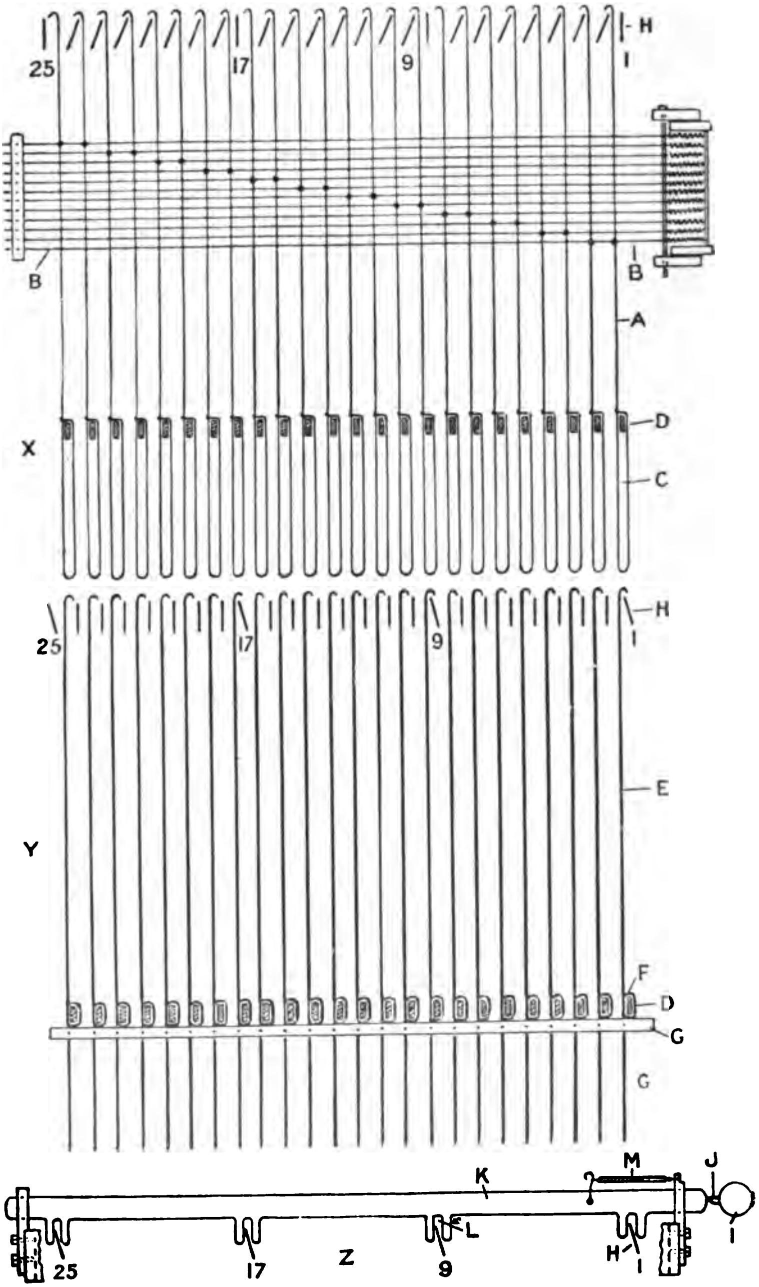

Fig. 204.

pierced with guide holes through which the straight lower ends of the hooks pass. The heads of the figuring hooks A are turned towards the card cylinder in the ordinary manner, but those of the twilling hooks E are turned in the opposite direction.

When in their ordinary position the lifting blades H are inclined towards the figuring hooks A in the usual way, but where the blades are in line with the twilling hooks they are twisted to a vertical shape so that they are clear of the upper end of the twilling hooks E. Each blade H is capable of being rocked upon its lower edge in such a manner that its upper edge is clear of the corresponding figuring hooks, as shown by the blades 1, 9, 17, and 25 in diagram X, Fig. 204. At the same time the upper edges of the blades, where they are in line with the twilling hooks, are moved under the bent ends of the latter, as shown by the blades 1, 9, and 17 in diagram Y. (It will be noted that the arrangement necessitates the use of one blade more than there are hooks in a short row.)

Operation of Twilling Needles.—The rocking movement of the blades H is obtained from a small revolving cylinder I in which projections J are fixed, each of the latter acting upon the end of a twilling needle K, as shown in the diagram Z in Fig. 204. The upper edge of each blade H, towards one end, fits within a recess L formed on the underside of a twilling needle K. As many needles K are provided as there are threads in a repeat of the binding weave, and each, by means of the recesses L, controls every fifth or every eighth blade H, according to whether the binding weave repeats upon five or eight threads. The pressure of a projection J moves a twilling needle K (each of which is acted upon for one pick in every five or eight picks, as the case may be) so that the blades to which the latter is connected assume the position shown by those numbered 1, 9, 17, and 25 in Fig. 204. These blades are thus put out of engagement with the figuring rows of hooks 8, 16, and 24, as shown in diagram X, and into position for engaging the rows of twilling hooks numbered 1, 9, and 17, as shown in diagram Y. When the griffe rises on the following pick the figuring hooks in each long row 8, 16, and 24 will thus be automatically left down. The twilling hooks 1, 9, and 17, however, will be raised and lift up the corresponding bars D, and as each bar supports a long row of figuring hooks, the rows 1, 9, and 17 will be automatically lifted. The arrangement causes one long row of figuring hooks to be left down, and one long row to be raised to each repeat of the binding weave, quite independently of the figuring cards; and each hook that is left down is next to a hook that is raised. That is, the jacquard lifts the ends in solid groups in forming the design, except that one end in each repeat of the binding weave is left down through the action of the twilling motion, while of the ends that are left down by the jacquard the same proportion is raised. A spiral spring M is used to return each twilling needle to its normal position after the pressure of the projection J has been removed.

Proportions of Hooks to Needles.—In Fig. 204, which shows a row of 12 needles connected to 24 hooks, the twilling needles K are arranged to produce 8-sateen binding weaves. Sometimes a machine is provided with 25 hooks to each row of 12 needles, by connecting one needle to three hooks, in order that it may be conveniently adapted for either 5 or 8-sateen binding weaves. The number of hooks per row of 12 needles ranges up to about 48 for 8-sateen weaves, in which case there are four hooks to each needle. For 40 hooks per row the needles are connected to the hooks in the order of 4, 3, 3 for four times, and this size can be used for either 5 or 8-sateen weaves; 32 hooks per row for 8-sateen weaves are arranged 3, 3, and 2 per needle for four times; and 30 hooks per row for 5-sateen weaves, 2 and 3 per needle alternately. With 5-sateen weaves and 30 hooks per row, the twilling needles, taken in the order in which they are acted upon, are connected to the blades in the order of—first needle to blades 1, 6, 11, 16, 21, 26, and 31; second needle to blades 3, 8, 13, 18, 23, 28, etc. With 8-sateen weaves and 32 hooks per row, the first twilling needle controls blades 1, 9, 17, 25, and 33; the second needle, blades 4, 12, 20, and 28, etc.

Operation of Card Cylinder.—One defect of this machine is that although each card may act for several successive picks, the operation of the twilling motion on every pick makes it necessary for the jacquard to be actuated continuously. The card cylinder is, therefore, pressed against the needles on every pick, but a motion is applied which prevents it from being turned except at the required intervals. The turning catch of the cylinder is put into and out of engagement in any desired order by means of a revolving disc upon which a stud rests that is fastened to the catch. The disc is provided with recesses into which the stud enters when the catch has to operate on the cylinder, and the disc can be so shaped that each card will act for 2, 3, or 4, etc., picks, or for an irregular number, such as 3, 3, and 2, or 4, 3, and 3.

Changing the Capacity and Sett.—The number of picks per card can be readily changed, but it is more difficult than in the pressure harness to alter the number of ends controlled by each needle in a machine. A reduction from the full capacity of a machine can be effected by taking from each row a number of hooks that is equal to or a multiple of the number of threads in the repeat of the binding weave, and connecting the needles to the hooks to correspond. Thus, a 40-row machine may be changed to 32 or 24 hooks per row, or to 35 or 30 hooks per row, etc. Smaller changes can also be made, as, for instance, a 32-row machine, arranged to produce 8-sateen binding weaves, can be altered to the equivalent of a 28-row machine by taking eight hooks off two rows—four off the end of one row and four off the beginning of the next row—which reduces the sett and capacity of the jacquard by one-eighth. The machine would then be refilled with 12 needles connected to the hooks in the order of 3, 2, 2, for four times. A set of cards, which had been used for the 32-row machine could be used in weaving the same design in a cloth one-eighth lower in the sett. A machine arranged to produce 5-sateen binding weaves requires the hooks to be taken off in fives consecutively—thus, in reducing from 30 hooks per row to the equivalent of 27½, three are taken off the end of one row and two off the beginning of the next row. The first row is then connected to the needles in the order of 3, 2, 2, 2 for three times, and the next in the order of 3, 2, 2 for four times. It is possible to obtain any number of hooks per row between 12 and the original capacity, and to thus use the same set of cards in weaving a design in different qualities of cloths. The ordinary method of casting out can, of course, also be employed, but this necessitates that the design be made upon a less number of threads than the number of needles in the machine.

System of Designing.—The method of painting out designs is exactly the same for the twilling jacquard as for the pressure harness, and a similar structure, with a steppy outline, is formed. Thus, a design is painted solid as shown at K in Fig. 203, and if the needles are connected to 2 and 3 hooks alternately, and the twilling motion produces 5-sateen binding weaves, while each card acts for three picks, the full weave of the first 20 ends and 16 picks will be as shown at L in Fig. 203. In the same manner, M in Fig. 203 shows the full weave of 16 picks of the design K, assuming that each needle is connected to two hooks, the twilling motion produces 8-sateen binding weaves, and each card acts for two picks. Taking the marks to indicate warp, the blanks in the figure represent ends that are left down on account of the lifting blades being made vertical and missing the figuring hooks, while the crosses in the ground indicate the lifts produced through the figuring hooks being operated by the bars that are raised by the twilling hooks.

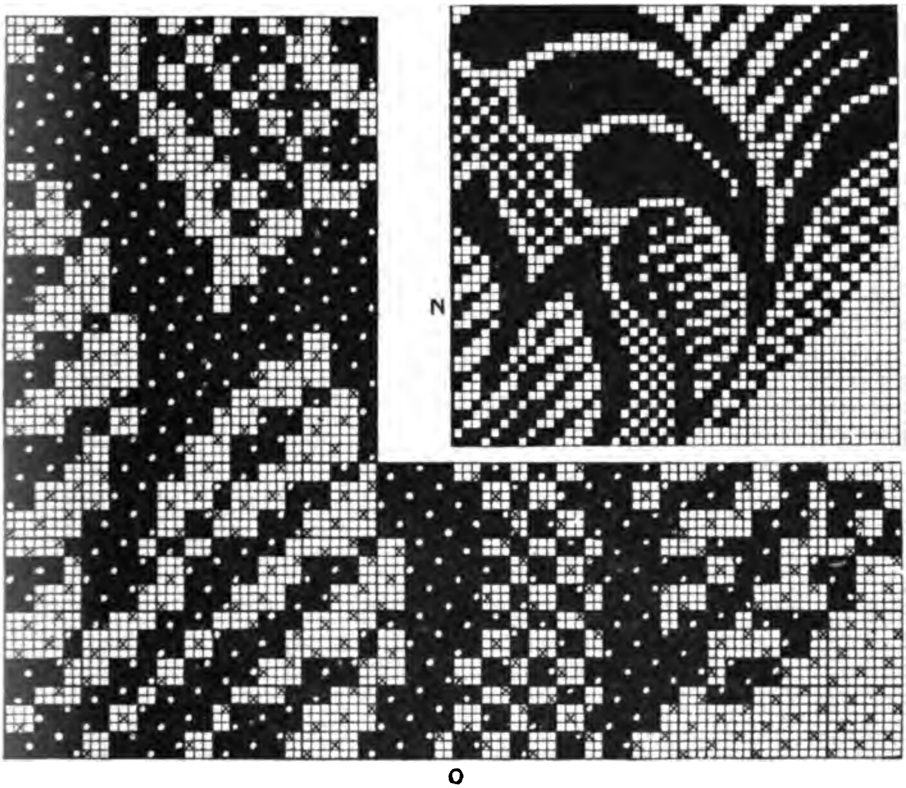

Fig. 205.

Production of Diversity of Effect in Damasks.—In both the pressure harness and the twilling jacquard systems the figure and the ground can only be woven in opposite sateen weaves, so that no variety of weave development can be produced. It is possible, however, to diversify the ornamentation of a fabric by painting a design in various ways, as shown at N in Fig. 205, in which a few effects are indicated to illustrate how a figure may be brought up in different tones. The finer the cloth, and the fewer the ends to each needle and picks to a card, the nearer the effects are to those that can be woven in a full-harness mount; and it should be kept in mind that very fine lines of figure may be indicated in the solid design, since each small square represents a group of threads. O in Fig. 205 shows the full weave of a portion of the design N, assuming that the hooks are connected to the needles in the order of 3, 3, 2; successive cards act for 3, 3, and 2 picks; and 8-sateen binding weaves are formed.

In designing for the twilling jacquard the counts of the design paper is in the proportion of—

$$\frac{\text{ends per inch}}{\text{hooks per needle}} : \frac{\text{picks per inch}}{\text{picks per card}}$$

For example, assuming that a cloth contains 96 ends and 140 picks per inch, and that 32 hooks are connected to 12 needles, and there are 10 picks to three cards—

$$\frac{96 \text{ ends}}{32 \div 12} : \frac{140 \text{ picks}}{10 \div 3} = 12 \times 14 \text{ design paper.}$$

The best qualities of damask cloths are generally woven with more picks than ends per inch, and the following are typical weaving particulars:—Warp—50's lea linen, 90 ends per inch; weft—70's lea linen, 130 picks per inch. 5-sateen binding weaves are only employed in the lower and cheaper qualities of cloths.

CHAPTER X

TAPESTRY AND UPHOLSTERY CLOTHS AND INGRAIN CARPETS

TAPESTRY AND UPHOLSTERY CLOTHS—Figured Double and Treble Plain Cloths—Combinations of Double Plain and Weft or Warp Figure—*Weft-Face Tapestry Cloths*—Figuring with the Harness Threads—Diversity produced by Mixing the Wefts—*Specially Stitched Weft Tapestry Cloth*—Special Weft Tapestry Mounting—Warp-Face Tapestry Cloth. SCOTCH, KIDDERMINSTER, OR INGRAIN CARPETS—*Double Plain Cloth Jacquard*—Operation of the Jacquard and Comber-Boards—Method of Designing—Limitation of the Mounting—*Weft-Face Ingrain Carpets*—Reversible Four-Ply Weft Structure—Methods of Producing Variety.

TAPESTRY AND UPHOLSTERY CLOTHS

ALMOST every class of fabric structure is used for tapestry and upholstery purposes ranging from cloths composed of one warp and one weft to those in which two or more series of threads are introduced in one or both directions. Some of the textures are mono-coloured, and the designs range from simple but striking effects to the boldest and most intricately developed styles of figures. Elaborate figure ornamentation is also combined with diversity of colour, whilst in certain textures the design is entirely due to colour—the figure being formed chiefly for the purpose of displaying different hues and tones.

Illustrations of various classes of the fabrics are included in the foregoing. Thus, extra warp structures are shown in Fig. 145 (p. 132), and Fig. 167 (p. 145), and an extra weft cloth is represented in Fig. 125 (p. 117). Multiple weft figured fabrics, woven on the principle illustrated by Figs. 131 to 138 (pp. 121-125), and Fig. 189 (p. 166), form an important class, and warp pile figuring (see Chapters XIX and XX) is largely employed; while certain special classes of the textures and the systems of loom mounting are described and illustrated in the following:—

Figured Double and Treble Plain Cloths.—A style of tapestry texture, which is composed of two series of warp and two series of weft threads, arranged in 1-and-1 order, is constructed by combining double plain weaves, two separate fabrics being formed in every part of the cloth, which are united by the threads changing from one side to the other. All, or any of the weaves, illustrated at A to H in Fig. 176 (p. 152), may be employed in a design. If the weft is in the same two colours as the warp, a solid dark, a solid light, and a mixed colour effect can be formed as represented in Fig. 175, but as shown at C to H in Fig. 176 the colours can be intermingled in a variety of ways. By having one or both of the weft colours different from the warp colours a still greater variety of intermingled colour effects may be produced. It is usual, however, to combine not more than four of the double plain weaves in a design. For convenience in the point-paper designing, a sectional harness arrangement, as represented in Fig. 183 or Fig. 184, should be employed, as then it is only necessary to paint out the various effects solid in different colours. The method in which four double-plain effects are designed and cut will be understood from the plans given in Fig. 185 and the accompanying description.

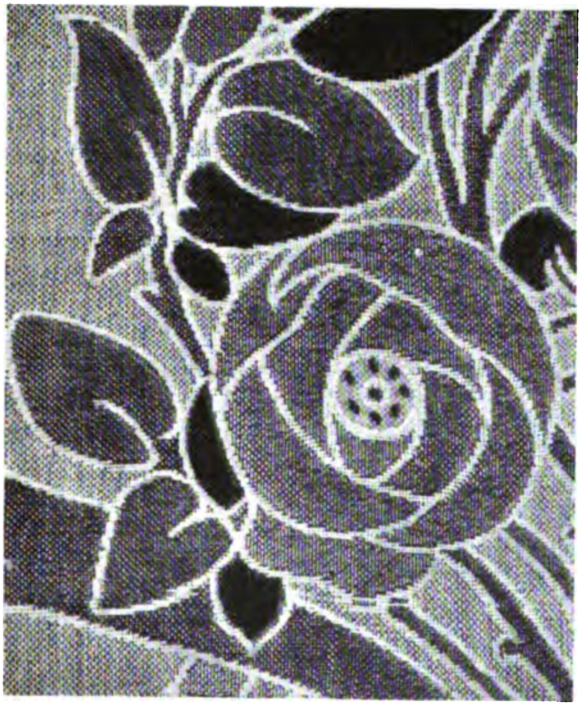

Fig. 206.

More elaborate cloths of a similar character to the double plain styles are woven with three series of threads in one direction and two series in the other direction, or with three series in both directions. Fig. 206 illustrates a fabric of the last type in which the weft is arranged 1 pick yellow silk, 1 pick blue silk, and

1 pick white cotton; and the warp, 1 end red cotton, 1 end green cotton, and 1 end white cotton. Seven effects are formed in the design, as indicated by the different marks in the corresponding sectional plan given in Fig. 207, which illustrates the method of designing for the texture. The weaves are so arranged that the yellow and blue silk wefts are chiefly brought to the surface, full use thus being made of the expensive threads.

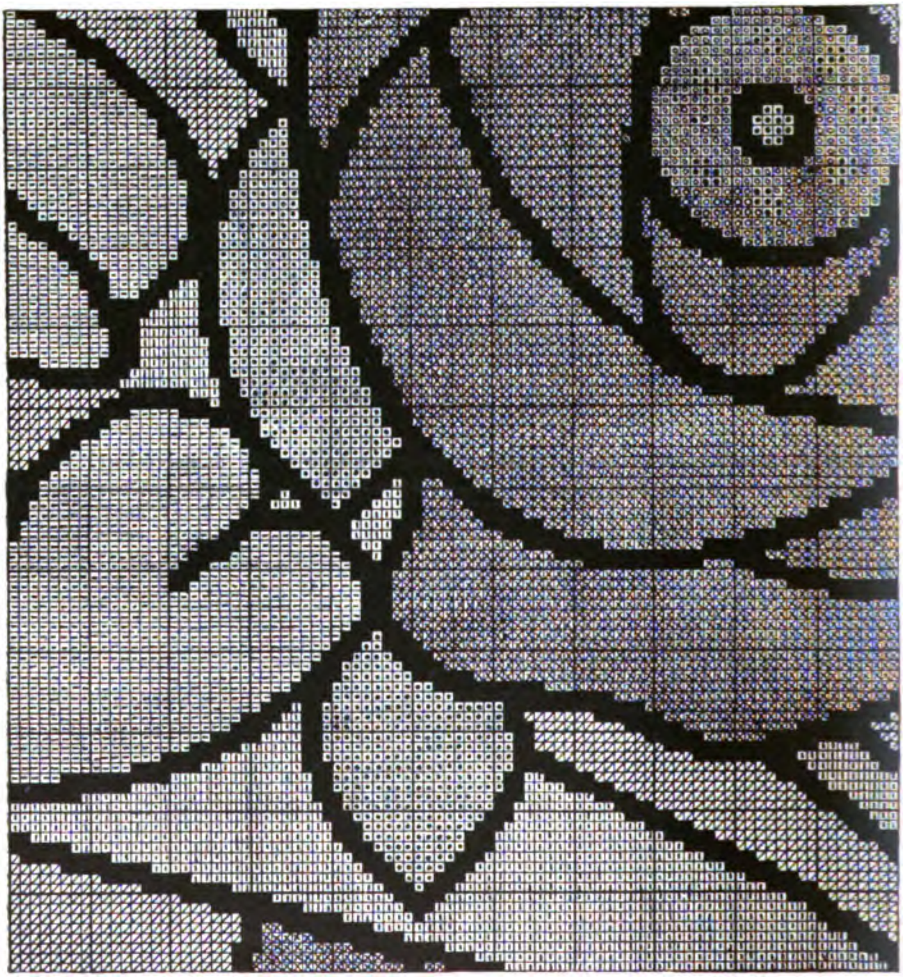

Fig. 207.

The seven weaves that are combined are illustrated in full at A to G in Fig. 208 in which the weave marks indicate warp. The lower part of each plan shows the arrangement of the threads as to their position in the cloth, the centre threads being represented by horizontal strokes, and the back threads by diagonal strokes. Linked with the face threads of the weaves a plan on 2 × 2 squares is shown in which the marks coincide with the corresponding effect in Fig. 207. The positions which the threads occupy in the different sections of the cloth, represented by the respective weaves A to G in Fig. 208, are indicated in the following list :—

Weave.	Face.	Back.	Centre.
A.	First weft and first warp.	Second weft and third warp.	Third weft and second warp.
B.	Second weft and second warp.	Third weft and third warp.	First weft and first warp.
C.	Third weft and third warp.	Second weft and first warp.	First weft and second warp.
D.	First weft and third warp.	Second weft and first warp.	Third weft and second warp.
E.	Second weft and third warp.	First weft and first warp.	Third weft and second warp.
F.	First and second wefts and first warp.	Third weft and third warp.	Second warp.
G.	First and second wefts and second warp.	Third weft and third warp.	First warp.

Plain weave is produced on both sides of the cloth, but in F and G two wefts are intermingled on the face, so that there are no weft threads in the centre. In A, B, C, D, and E there are both weft and warp threads in the centre which, however, do not interlace with each other, but simply serve as wadding threads, the picks passing over the ends.

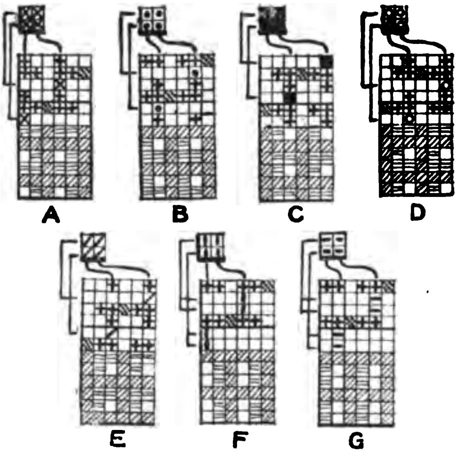

Fig. 208.

The jacquard and harness should be arranged in three equal sections to correspond with the three series of warp threads, and three cards (one for each weft) are cut from each horizontal space of the design given in Fig. 207. Assuming that the different effects in the design are represented by the letters A to G, to coincide with the lettering of the corresponding plans in Fig. 208, the card-cutting particulars of Fig. 207 are as follows :—

	First Warp Section.	Second Warp Section.	Third Warp Section.
First weft.	Cut A, E, and F plain.	Cut B and E solid, and G plain.	Cut C and E solid, and D plain.
Second weft.	Cut A solid, and C, D, and F plain.	Cut A, C, and D solid, and B and G plain.	Cut C and D solid, and A and E plain.
Third weft.	Cut A, B, F, and G solid.	Cut B, F, and G solid.	Cut D and E solid, and B, C, F, and G plain.

The card-cutting process is simplified by going through the design three times separately, once for each weft; and, further, if each section of the warp is controlled by a separate set of cards, the cards may be cut for each weft and each warp independently, the design being gone through nine times.

Combinations of Double Plain and Weft or Warp Figure. — In addition to forming figure by interchanging the fabrics in the double and treble structures, as described and illustrated in the foregoing, the cloths can be ornamented by floating the weft or warp threads, and in Fig. 209 a rich tapestry texture is represented in which two wefts are employed, both of which are floated on the surface. The arrangement in the weft is 1 pick dark green silk and 1 pick yellow silk, and in the warp, 1 end brown cotton and 1 end white cotton. In the corresponding sectional design given in Fig. 210 the solid marks represent a dark double - plain effect in which the first weft interweaves with the first warp on the surface, and the blanks, a similar light effect produced by the second weft interweaving with the second warp. The circles show where the first weft floats loosely on the surface, and the diagonal marks the second weft, and it will be seen that both wefts are floated upon a background formed by each double-plain effect. A feature of the example is that the cloth is perfectly reversible, a dark effect, in either double plain or weft float, on one side, having a corresponding light effect on the other side. The two fabrics are bound together :—(*a*) where the two plain structures change positions, both the ends and the picks interchanging at these places ; and (*b*) where a weft is floated on a surface in which the other weft is used to form the plain weave. Where a weft forms a plain surface and then floats loosely no binding of the fabrics is made. The method in which the picks interlace will be understood from an examination of the complete weaves given in the lower portion of Fig. 210, the several sections of which are lettered A, B, C, and D. A corresponds to the solid marks in the design, B to the circles, C to the diagonal marks, and D to the blanks. The marks in the weaves indicate weft, and it will be seen that the picks interchange between A and C, A and D, and B and D, but not between A and B, nor C and D. (See also p. 154.)

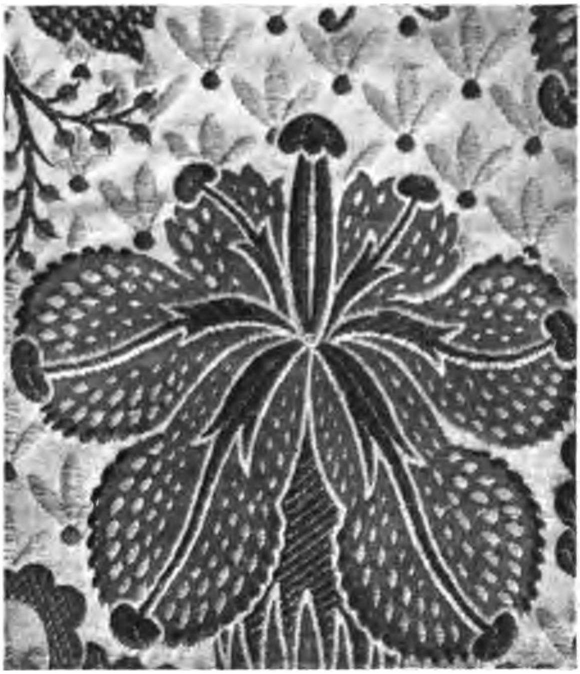

Fig. 209.

With a jacquard and harness arranged in two equal sections to correspond with the two series of warp threads, two cards are cut from each horizontal space of the design given in Fig. 210 as follows :—

	Brown Warp Section.	White Warp Section.
First card (green pick).	Cut the diagonal marks solid, and the full squares and blanks plain.	Cut the diagonal marks and the blanks solid.
Second card (yellow pick).	Cut the full squares and circles solid.	Cut the circles solid, and the full squares and blanks plain.

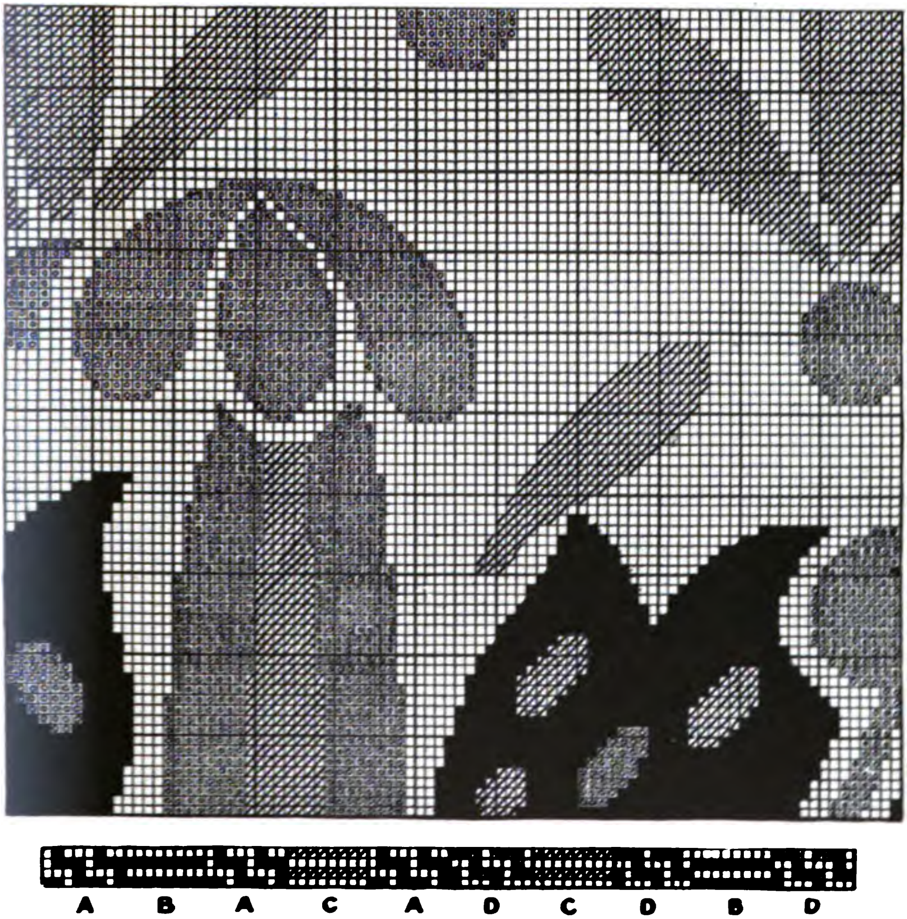

Fig. 210.

Weft-Face Tapestry Cloths.— A variety of tapestry texture is represented in Fig. 211, in which the design is due to diversity of colouring in the weft. Two series of ends are employed, arranged as follows :—2 binding ends of 2/80's cotton, 2 figuring ends of 2/20's cotton, 60 ends per inch. The weft is 2-ply 10's worsted, with 14 picks of each colour per inch. In the example there are four series of picks, but fewer or more series may be employed according to the number of colours that are required on the surface in each horizontal line of the cloth.

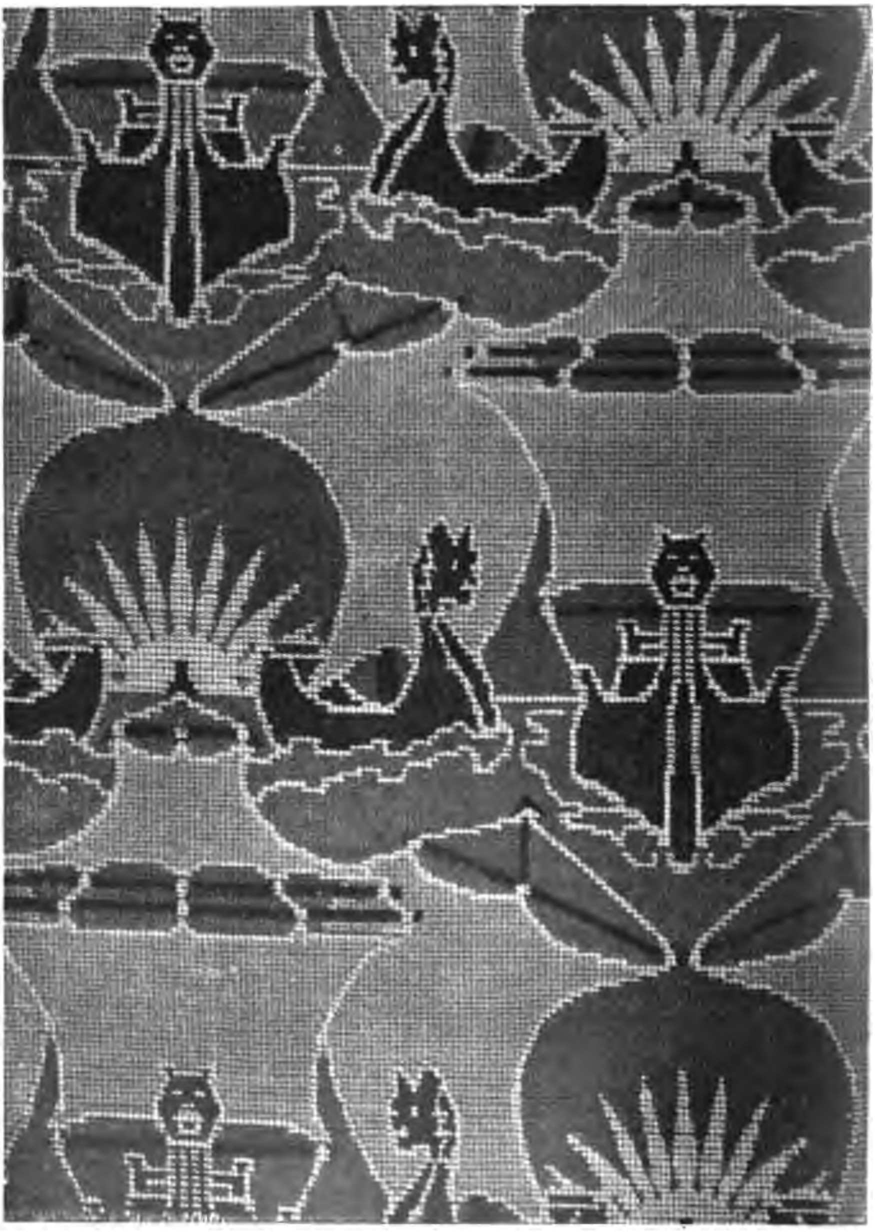

Fig. 211.

Each group of picks corresponds to one pick on the surface, and each colour of weft passes over the figuring ends where it is required to form figure, one weft replacing another in succeeding horizontal sections of the design. The wefts are stitched on both sides of the cloth by the binding ends, the odd binding ends being raised on one group of picks, and the even binding ends on the next group. That is, the binding ends are raised and depressed alternately in an order that corresponds with the number of picks in each group—in 3-and-3 order if three wefts are employed, and in 4-and-4 order in the case of four wefts, etc. Each weft is stitched in longitudinal lines on the surface, which thus has the appearance of a weft rib.

In weaving the cloth the binding ends are drawn upon two healds, as represented at H in Fig. 213, and it is, therefore, only necessary to consider the figuring ends in constructing a design. The figure is painted solid in different colours, as represented in the upper portion of Fig. 212, while the paper indicates the ground colour; and as many cards are cut from each horizontal space as there are wefts employed. In weaving the cloth right side up the cutting particulars for each card are :—Cut all but the weft colour that is required on the surface. The jacquard lift is made easier, however, by weaving the cloth wrong side up, in which case the card cutting particulars are :—Cut only the weft colour that is required on the surface. The plan in the lower portion of Fig. 212, in which the marks indicate weft, shows the complete weave produced by the picks 17 and 18 and the figuring ends 17 to 40 of the solid design; the vertical marks indicating the 4-and-4 working of the healds, while the other marks represent the surface floats of the different wefts.

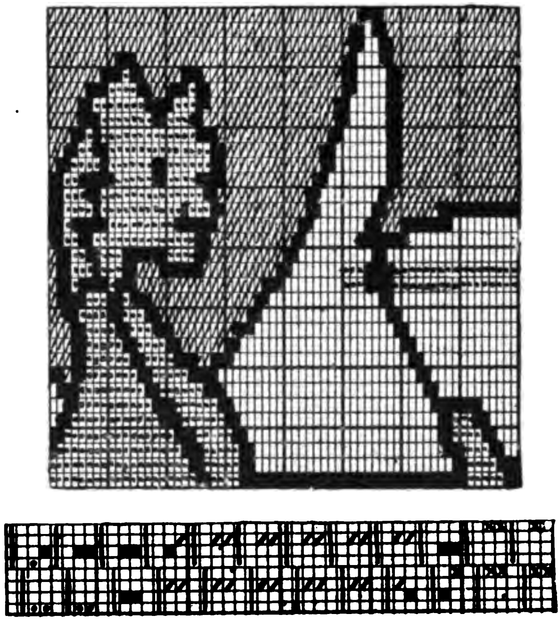
Fig. 212.

If only two wefts are employed in the structure represented in Fig. 211, the cloth is perfectly reversible, but with more than two wefts all except the one on the surface are interwoven alike on the underside, where the colours, therefore, show indiscriminately. In some weft tapestry cloths a plain weft-face is produced, as shown in the fabric represented in Fig. 222, the ends being drafted as indicated at D in Fig. 224. Also, the cloths may be made perfectly reversible, when more than two wefts are employed, by interweaving the surplus wefts in the centre in the manner illustrated by the plans above E, F, G, and H in Fig. 224.

Figuring with the Harness Threads.—In the texture represented in Fig. 211 the figuring ends really serve as stuffer ends, as they lie between the wefts on the face and back, and do not show on either side of the cloth. In the same structure, however, the cloth is sometimes cheapened by floating the figuring ends on the surface in place of a weft, one pick of weft in each group thus being saved. Long warp floats require to be stopped by one or other of the wefts; and the formation of large masses of figure by the figuring ends is not suitable, but they are conveniently used in outlining a design and in forming veins and stems.

A better quality of cloth than the example illustrated in Fig. 211 is produced by employing worsted yarns for the figuring ends in place of cotton, the following being suitable weaving particulars :—

Warp—2 figuring ends of two-ply 2/40's worsted, 2 binding ends of 2/80's cotton; 56 ends per inch.

Weft—10's worsted, 20 picks of each colour per inch.

The worsted ends are dyed the same colour as one of the wefts, and these two yarns interweave in plain order in the ground of the design, while the figure is produced by bringing the other wefts to the surface in the manner illustrated in Figs. 211 and 212. The only difference from the preceding system of cutting the cards is that the cards for the picks which are in the same colour as the figuring warp are cut plain. The counts of the design paper is in the proportion of the figuring ends per inch to the picks of each colour per inch.

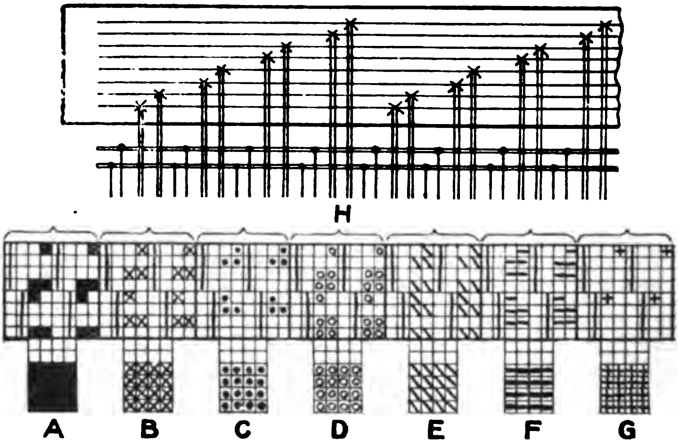

Fig. 213.

Diversity produced by Mixing the Wefts.—In each of the foregoing methods of ornamentation variety of colour effect can be produced by bringing two of the wefts to the surface in some parts of the design and only one in other parts. For example, assuming that four colours of weft are employed, of which the fourth is the same in colour as the figuring ends, as described in the preceding paragraph, seven different effects can be produced, as represented at A to G in Fig. 213. The lower portion of the plans illustrates how the different effects may be painted upon design paper, if the heald-and-harness draft indicated at H is employed. The upper portion, in which the marks indicate weft, shows the corresponding complete weaves, including the binding ends which work in 4-and-4 order. The card-cutting particulars of each horizontal space of the solidly painted design, to weave the cloth right side up, are :—First card—cut B, C, F, and G; second card—cut A, C, E, and G; third card—cut A, B, D, and G; fourth card—cut plain. The colours are brought to the surface as follows:—A first weft, B second weft, C third weft, D first and second wefts together, E first and third wefts together, F second and third wefts together, and G the fourth weft along with the warp colour. There is also the difference in the effects that where two wefts are brought to the surface the figure is more solid than where there is only one.

Specially Stitched Weft Tapestry Cloth.—Fig. 214 represents a class of figured weft rib tapestry which is similar in appearance to that represented in Fig. 211, but the rib lines are finer, and the cloth is firmer and more suitable for upholstery purposes. In this case a binding weft is employed, so that the picks are not so liable to slip. Also there are two stitching warps, one of which binds the weft floats firmly on the surface, while the other stitches the wefts which are not required on the surface loosely to the underside. The particulars of the cloth are as follows:—Warp—1 face stitching end, 2/80's black cotton; 1 figuring end, two-ply 2/24's black cotton; 1 back stitching end, 2/80's brown cotton; 1 face stitching end, 2/80's black cotton; 1 figuring end, two ply 2/24's black cotton. 24 two-ply figuring, 24 face stitching, and 12 back stitching ends per inch. About 103 yards of figuring, 127 yards of face stitching, and 108 yards of back stitching warp are required for 100 yards of cloth. Weft—3 figuring picks of 9's or two-ply 18's worsted in different colours, 1 binding pick of 2/80's cotton, 30 figuring picks of each colour, and 30 binding picks per inch.

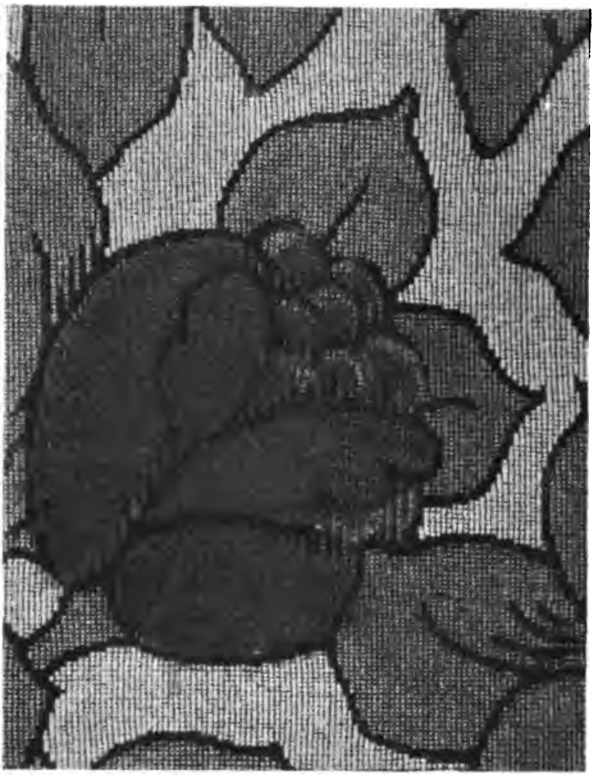

Fig. 214.

In designing the figure the different effects are simply painted solid in different colours, as shown in Fig. 215, which corresponds with a portion of Fig. 214. Each vertical space of Fig. 215 represents a two-ply figuring end, and each horizontal space a pick of each weft, and the counts of the design paper with the foregoing particulars is, therefore, in the proportion of 24 ends to 30 picks, or 8 × 10. The figuring ends are used in forming the outline and the veins of the ornament and in shading the figure, as shown by the solid marks in Fig. 215; while two of the wefts produce the figure, and the third the ground, as represented by the dots, diagonal marks, and blanks respectively.

Special Weft Tapestry Mounting.—Although the cloth represented in Fig. 215 is very complex, both the painting out of a design and the card cutting are simple,

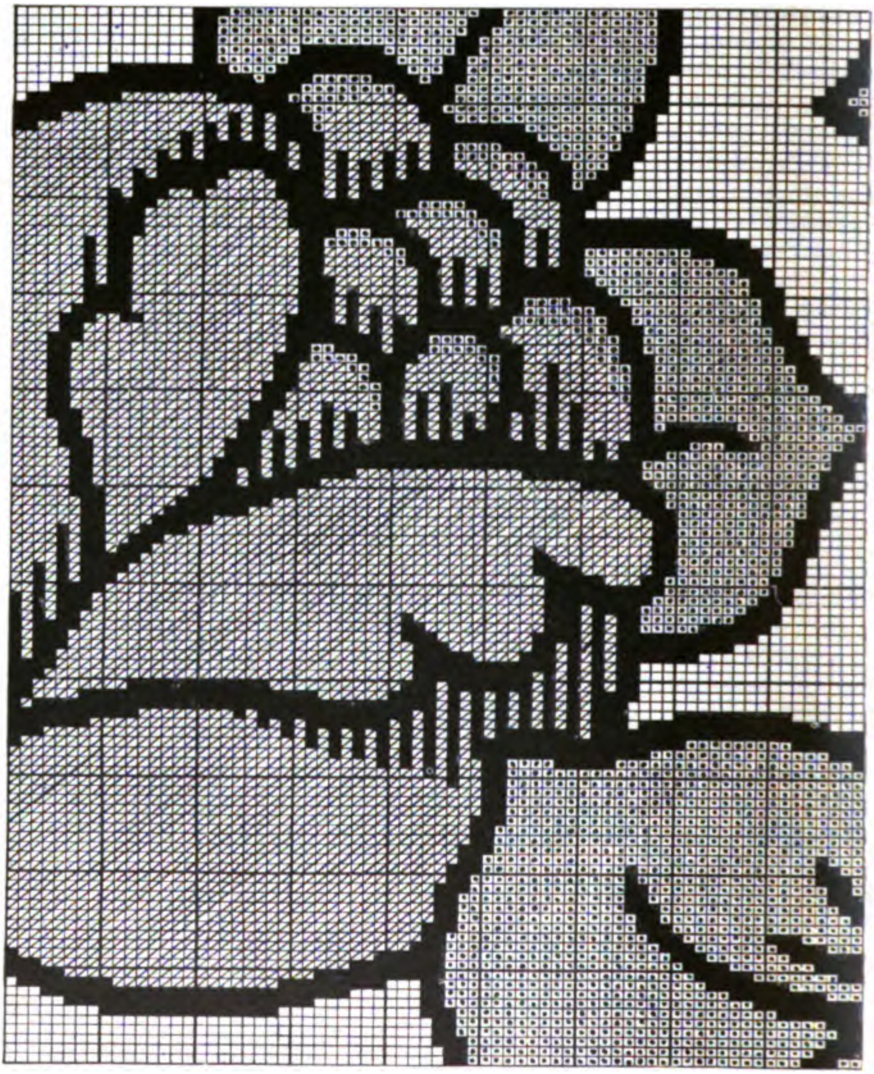

Fig. 215.

which is due to the employment of a very ingenious and interesting system of jacquard harness, lifting rod, and heald mounting. The arrangement is illustrated at A in Fig. 216, while B shows the order in which the ends are drafted. The face binding ends pass regularly over the figuring picks and under the binding picks on the right side of the cloth, and are, therefore, conveniently drawn upon a heald C. The harness is in two longitudinal sections, the figuring ends being drawn upon the front portion D, and the back stitching ends upon the rear portion E.

As shown in the diagram A, the cords of the back stitching harness E are connected with alternate cords of the figuring harness, and are also provided with loops, through which lifting rods F are passed longitudinally, in the manner illustrated in Fig. 188 (p. 165). In this case, however, the rods are used simply to enable the back-stitching harness to be operated independently of the figuring harness. The hooks and needles are arranged the same as in an ordinary machine, and it will be seen that there are twenty ends in the cloth to each row of eight hooks and needles.

The cloth is woven wrong side up; the heald is left down on the figuring picks and raised on the binding picks, as shown at G in Fig. 216, while the rods are raised by means of special hooks in the jacquard, in the order indicated at H. Four cards are cut from each horizontal space of the design given in Fig. 215 as follows :—

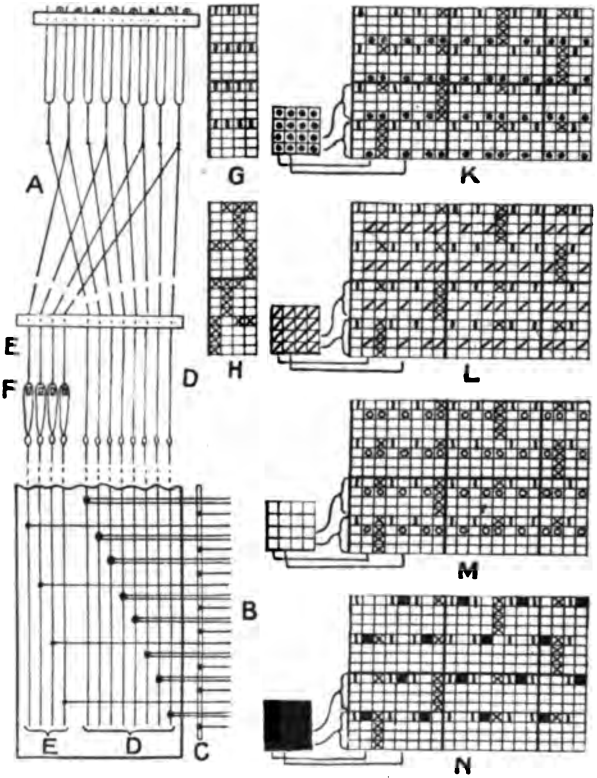

Fig. 216.

First figuring pick—cut the dots.
Second figuring pick—cut the diagonal marks.
Third figuring pick—cut the blanks.
Binding pick—cut the solid marks plain.

The four effects that are formed in the cloth are indicated in full at K, L, M, and N in Fig. 216, each of which is connected by lines with a plan that is indicated the same as the corresponding effect in Fig. 215. K brings the first weft to the surface on the right side of the cloth, L the second weft, M the third weft, while N produces the warp figure. The marks indicate ends raised in weaving the cloth wrong side up; the crosses show the lifts produced by the rods, the vertical marks the heald lifts, while the other marks represent the lifts produced by the figuring harness. The rods are lifted one at a time on the figuring picks, and stitch the wefts that are not forming figure in 4-sateen order on the reverse side of the cloth. Three of the rods are always left down on the figuring picks, and it is to automatically prevent the ends controlled by them from interweaving with the weft that forms the pattern on the under surface (the right side), that the back stitching harness cords are connected to the figuring harness cords. Where a weft forms the pattern on the right side of the cloth the figuring ends are raised, and with them the

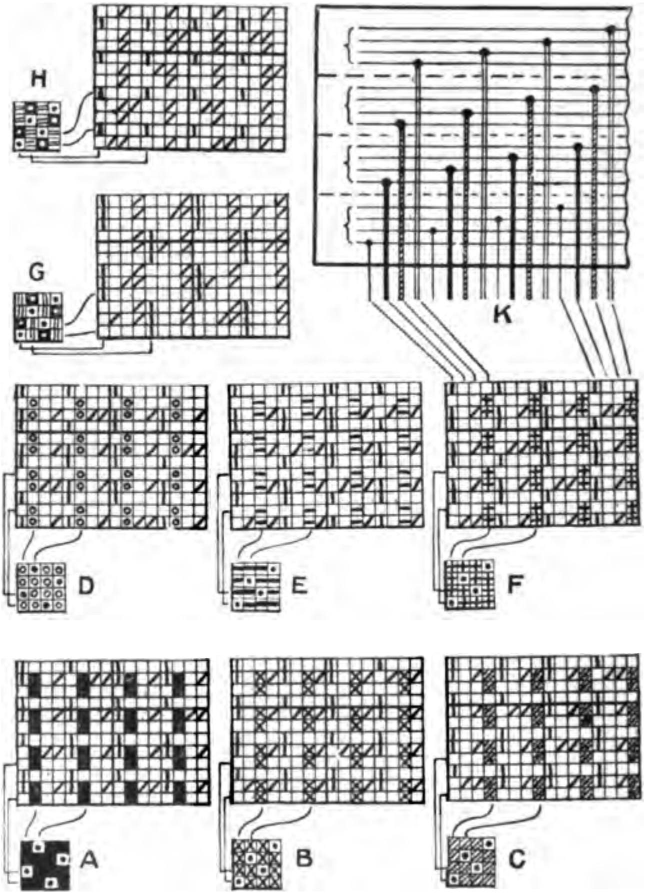

Fig. 217.

corresponding back stitching ends, so that the latter do not interweave with the weft on the face side of the cloth. The back stitching ends really form a loosely woven cloth with the weft on the reverse side, which, however, is stitched to the face texture by the interweaving of the back stitching ends with the binding picks. This is effected by leaving one rod down on each binding pick, as shown, by the blanks on the picks, 4, 8, 12, and 16 in the plan H, Fig. 216.

Warp-Face Tapestry Cloth.—A class of tapestry cloth, in which the design is due to colour, as in Fig. 214, is also largely made which has a warp-rib surface, the pattern in this case being chiefly due to employing two, three, or more differently coloured series of figuring ends. Two strongly contrasting figuring wefts—one very dark and the other very light—are, however, introduced, both of which form an effect on the surface in conjunction with each warp colour, and also produce small parts of the ornament independently. With three warp colours, which is a common arrangement, eight effects can be produced in any part of the cloth—six by combining each warp colour with each weft colour, and two by the wefts separately. Further, planting the warp colours is largely resorted to, and very great diversity of colour ornamentation is thereby obtained in the width of a fabric. In addition to the figuring warps and wefts, a fine binding warp and weft are employed, as shown in the following particulars of a cloth :—

Warp—1 binding end, 2/100's black cotton ; 3 figuring ends, 2/30's cotton in different colours ; 27 ends of each kind per inch.

Weft—2 figuring picks, 5's cotton in different colours ; 1 binding pick, 2/100's black cotton ; 23 picks of each kind per inch.

A design is painted in different colours to indicate the effects required on the surface, and in Fig. 217 eight effects are represented by the plans A to H, which are shown connected by lines with the corresponding complete weaves in which the marks indicate warp. The first, second, and third figuring warps are respectively interwoven with the first figuring weft at A, B, and C, and with the second figuring weft at D, E, and F, while G brings the first weft to the surface, and H the second weft. The vertical marks in the complete weaves indicate the lifts of the binding ends, and distinctive marks, which correspond with those shown in the plans A to F, represent the lifts of the figuring ends in forming the pattern on the surface, while the diagonal marks show the other lifts of the figuring ends. In each weave A to F the figuring ends required on the surface float over both figuring picks, and the binding ends are raised on the binding picks. On the figuring picks that are required to form the pattern on the surface along with the figuring ends, only the latter are raised, as shown on the first of each group of three picks in A, B, and C, and on the second of each group in D, E, and F. On the figuring picks that are not required to show on the surface, one of the remaining figuring warps is raised continuously, and the other in 1-and-3 sateen order, while the binding ends are lifted in 3-and-1 sateen order. The sateen order is indicated by the dots in the small plans A to F.

The weaves G and H in Fig. 217 illustrate two different methods of bringing the figuring picks to the surface, but in both cases the wefts are stitched by the binding ends. Two figuring warps are raised in 1-and-3 sateen order on the picks that are not required on the surface, and the remaining figuring warp on all these picks as well as on the binding picks. The dots in the small plans G and H show the sateen order of lifting one figuring warp, and the hollow circles the order of lifting the other figuring warp.

All the warps require to be controlled by the harness, and assuming that an ordinary jacquard and harness is arranged in four equal sections, and drafted as shown at K in Fig. 217, the ends will be lifted as indicated in the following, each horizontal space in the solid design representing three cards.

	Binding Warp.	First Figuring Warp.	Second Figuring Warp.	Third Figuring Warp.
Dark figuring pick.	Cut all but the dots in D, E, and F, and cut G plain.	Cut A and D solid, and cut the dots in E, F, and H.	Cut B, E, F, and H solid, and cut the dots in D.	Cut C, D, E, and F solid, and cut the hollow circles in H.
Light figuring pick.	Cut all but the dots in A, B, and C, cut G plain, and cut H solid.	Cut A and D solid, and cut the dots in B, C, and G.	Cut B, C, and E solid, and cut the dots in A and the hollow circles in G.	Cut A, B, C, F, and G solid.
Binding pick.	Cut A, B, C, D, E, and F solid, and cut G plain.	—	Cut H solid.	Cut G solid.

SCOTCH, KIDDERMINISTER, OR INGRAIN CARPETS

This is a class of texture in which the ornamentation is due to the use of differently coloured threads. In the simpler cloths the structure consists of two differently coloured plain fabrics, which are interchanged with each other in forming the design, as illustrated at N in Figs. 70 and 71 (p. 74). A number of different colour effects can be produced by combining two colours of warp with two different colours of weft, as described in reference to Fig 176 (p. 152) and Fig. 185 (p. 159). Also two or three warps are combined with two or three wefts, as illustrated in Figs. 206, 207, and 208 (pp. 187-189) in order to produce greater variety of pattern and a thicker structure. Designs in which only two double-plain effects are combined can be very conveniently woven by means of a special jacquard and harness mount; and although the class of Scotch carpet, for which the machine is particularly suitable, has been largely superceded by other makes, the arrangement embodies such a valuable principle of weaving that it is described and illustrated in the following:—

Double-Plain Cloth Jacquard.—This machine is specially arranged for weaving cloths in every part of which there are two differently coloured equal plain fabrics, one above the other, which interchange in forming the design. The jacquard is a compound or "twin" machine which is operated in conjunction with four working comber-boards. The ends, which are arranged as to colour in 1-and-1 order, are drawn in special order upon the harness. The principle of the machine and draft is illustrated in Fig. 218. To correspond with the two colours of warp there are two sets of hooks A and B, the hooks A having their bent upper ends turned towards the card cylinder, while those of B are turned towards the spring box. Only one series of needles C is employed, but each needle controls a hook of each set. There are two griffes carrying two sets of lifting blades E and F, and each blade is inclined towards the hooks that it governs, but whereas the hooks A, when in their normal position, are over the blades E, the hooks B are clear of the blades F. The harness cords have knots G tied upon them which rest (when the cords are not raised by the jacquard) upon the working comber-boards K, L, M, and N. Two comber-boards are allotted to each set of hooks and harness cords in order that each colour of warp may be lifted in plain order by the comber-boards independently of the jacquard.

The ends are drawn upon the harness as indicated at H in Fig. 218, in which the solid lines represent, say, dark ends, and the shaded lines light ends. The dark ends are drawn upon the harness cords that pass through the front two boards N and M, and the light ends upon the cords that pass through the rear boards L and K. It will be seen that by raising the board N the odd dark ends will be lifted, by raising L the odd light ends, by raising M the even dark ends, and by raising K the even light ends.

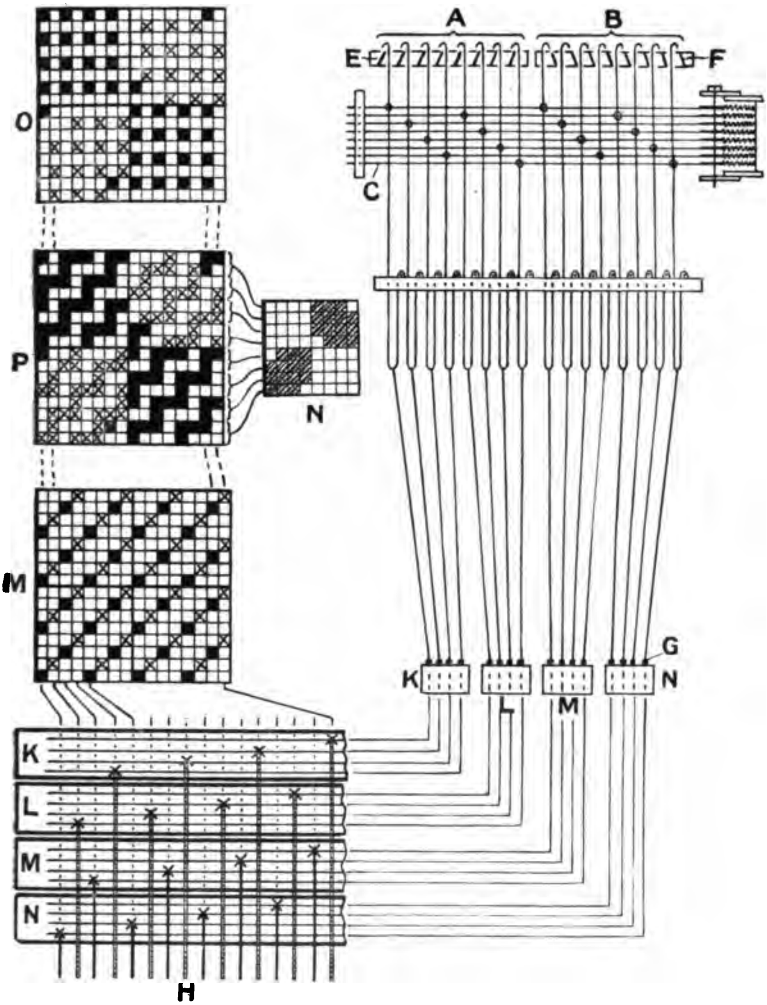

Fig. 218.

The needles are connected to the hooks in such a manner that the harness cords pass to the comber-boards without being crossed. Thus, the hooks in each set, in the order of 1, 2, 3, 4, 5, 6, 7, 8, are connected to the needles in the order of 1, 3, 5, 7, 2, 4, 6, 8, because the odd ends of each colour are drawn upon the harness of one board, and the even ends upon the harness of the next board.

The weft is in two colours, and is inserted in the order of a pick of each alternately. On one dark pick the odd dark ends are lifted by one board, and on the next dark pick the even dark ends by the next board; the plain weave of the dark fabric thus being formed. In the same manner on one light pick the odd light ends are raised by one board, and on the next light pick the even light ends by the other board, so that the plain weave of the light fabric is formed. The purpose of the jacquard is to lift the light ends on dark picks where a light surface is required, and to lift the dark ends on light picks in forming a dark surface.

Operation of the Jacquard and Comber-Boards.—The operation of the machine is as follows:—Each card acts for two picks—a pick of each colour—during which the two griffes are operated alternately. A blank in a card presses a hook A away from the path of a lifting blade E, whereas a hook B is pressed over a blade F. On the other hand, a hole in a card allows a hook A to remain over a blade E, and a hook B to remain clear of a blade F. Thus, one hook of a pair controlled by the same needle is certain to be raised on one pick, and the other left down on the other pick. Taking the order of wefting to be 1 dark, 1 light, the complete order of shedding is as follows:—

Odd spaces of design	First pick (dark)—	hooks A (light)	and board N (dark)	are raised.
	Second „ (light)—	„ B (dark)	„ L (light)	„
Even spaces of design	Third pick (dark)—	„ A (light)	„ M (dark)	„
	Fourth „ (light)—	„ B (dark)	„ K (light)	„

The full weaves that are produced will be understood from an examination of the plans given at M, N, O, and P in Fig. 218. M shows the weave that is formed by the lifting of the boards, the solid marks representing the dark ends, and the crosses the light ends. Assuming that the marks of the plan N are cut upon the cards, the lifts indicated at O will be produced by the jacquard, the crosses representing light ends lifted on dark picks, and the full squares dark ends lifted on light picks. The complete weave formed by the boards and the jacquard in combination is, therefore, as shown at P, in which the full squares represent the dark surface and the crosses the light surface. In cutting the cards from a design, holes have to be cut to correspond with the positions where the colour of warp is required on the surface which is controlled by the hooks that normally are over the lifting knives. (P may be compared with N in Fig. 70, p. 74.)

Method of Designing.—In painting out a design the figure is indicated solid, and no weave marks are inserted upon either the figure or the ground. The sectional design given in Fig. 220 may be taken as an example, in which it will be seen that variety of effect can be obtained to some extent in painting in the figure. Each vertical space of the design paper corresponds to two ends, and each horizontal space to two picks, and there is, therefore, a saving in cards of three-fourths.

Limitation of the Mounting.—The limitation of the machine is that only two effects are possible in the cloth since each colour of warp can only be interwoven with the colour of weft that is allotted to it. Each effect does not necessarily require to be in a solid colour, as the weft colours may be different from the warp colours, but the interweaving of each colour of warp with both colours of weft is impossible. In many cases this is a disadvantage as compared with the effects that can be woven in a machine in which every end is controlled by a separate needle. Also, as the two fabrics are separate except where they interchange, the wear of the cloth is not so good as that of a solid structure of the same weight and thickness. The original type of Kidderminster carpet has, therefore, been modified in various ways, and as will be seen by comparing the following examples with Figs. 211 to 216, the textures, in the modified forms, are very similar in principle of construction to weft-face tapestry cloths. Thicker and stronger yarns are, of course, employed in the carpets.

Weft-Face Ingrain Carpets.—Fig. 219 represents a fabric in which the design is due to the interchange of two differently coloured wefts, while the corresponding

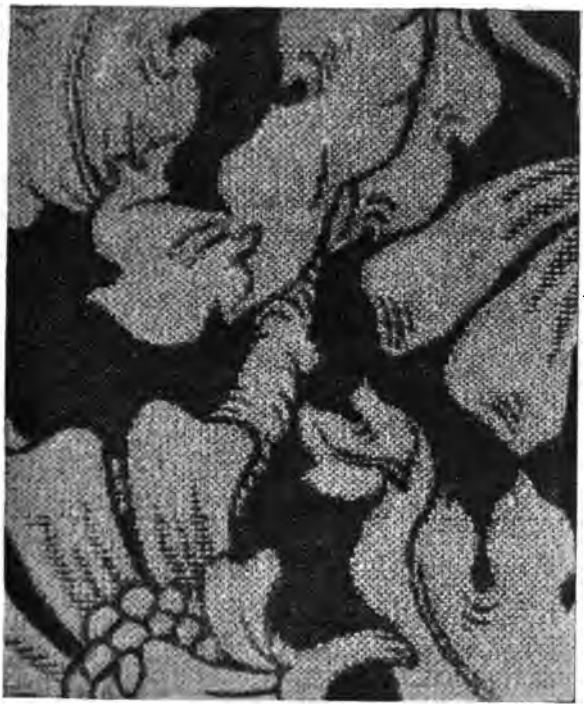

Fig. 219.

sectional plan, given in Fig. 220, illustrates the method of painting out a design. The warp is arranged—1 binding end, 1 two-ply figuring end, as shown in the heald-and-harness draft given at A in Fig. 221. In some cases the figuring ends are single, but if they are two-ply they should be drawn separately through double-eyed mails in order that they will spread out, and give a fuller appearance to the cloth. If an ordinary form of jacquard is used two cards are cut from each horizontal space of Fig. 220, as follows :—First card, cut the blanks ; second card, cut the marks. The healds are operated in 2-and-2 order, and the complete weaves, given at B and C in Fig. 221, are produced in the figure and ground respectively. The cloth is perfectly reversible, a dark figure on a light ground being formed on one side, and a light figure on a dark ground on the other side. Sometimes, however, one of the wefts is chintzed in order to develop a portion of the figure in a third

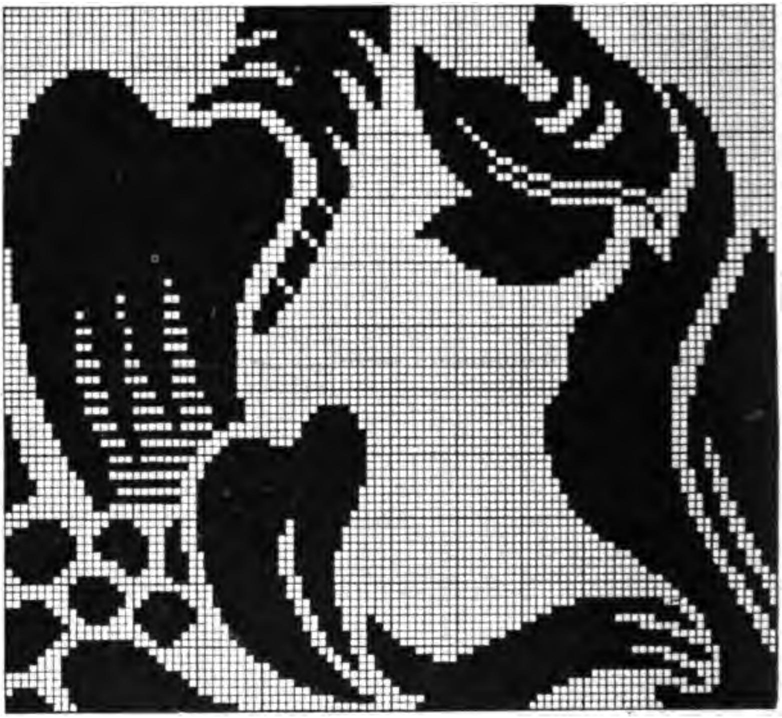

Fig. 220.

colour, in which case the cloth is generally not reversible, because the chintzed weft produces horizontal lines in the ground on the underside.

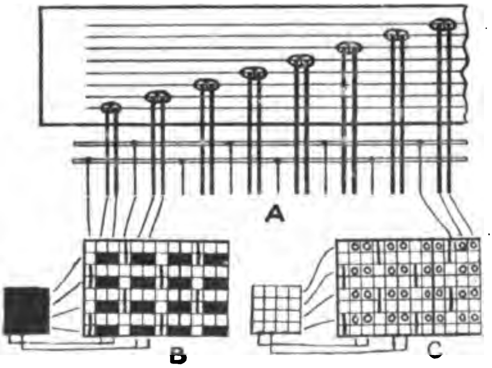

Fig. 221.

From an examination of the weaves given at B and C in Fig. 221 it will be seen that the harness ends left down on the first pick of each pair are raised on the second pick. The double-plain machine, illustrated in Fig. 218, can be adapted to weave the cloth by connecting each harness cord to two hooks that are controlled by the same needle. The arrangement then enables one card to act for two picks, as the ends left down by the hooks A on the first pick are automatically raised on the second pick by the hooks B.

Reversible Four-Ply Weft Structure.—The class of structure, represented in

Fig. 219, is also made with more than two series of differently coloured wefts, and in order to enable changes to be readily made from one cloth to another, an ordinary form of heald-and-harness mount is chiefly employed, and the two figuring ends, which alternate with each binding end, are drawn on separate harness cords. Fig. 222 represents a fabric in which the design is formed in four differently coloured wefts, the following being suitable weaving particulars :—

Warp—1 cotton binding end, 3/24's ; 2 jute figure or stuffer ends, 9 lbs. per spyndle ; 7 binding ends and 14 jute ends per inch.

Weft—60 yards per oz. worsted or woollen ; 14 picks of each colour per inch. The binding ends in this class of cloth require to be from 60 to 120 per cent. longer than the jute ends, according to the thickness of the weft and the number of picks per inch.

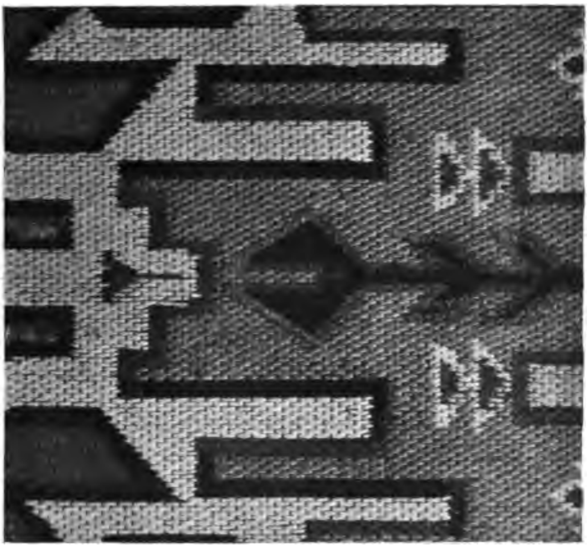

Fig. 222.

Fig, 223 shows a portion of the design given in Fig. 222, the different marks representing different colours of weft on the surface, while D in Fig. 224 represents a form of heald-and-harness mount that is used in weaving the cloth. The plans E, F, G, and H in Fig. 224 respectively correspond with the four effects represented in Fig. 223, and each plan is connected by lines with the corresponding complete weave in which the marks indicate weft. The healds are operated in 4-and-4 order, as indicated by the vertical marks ; and if the draft D in Fig. 223 is employed four cards are cut from each horizontal space of the design as follows :—

First card—cut G solid, and odd ends of F and H.
Second ,, ,, H ,, ,, ,, E ,, G.
Third ,, ,, E ,, ,, ,, F ,, H.
Fourth ,, ,, F ,, ,, ,, E ,, G.

In the complete weaves, the marks which correspond with those in the solid

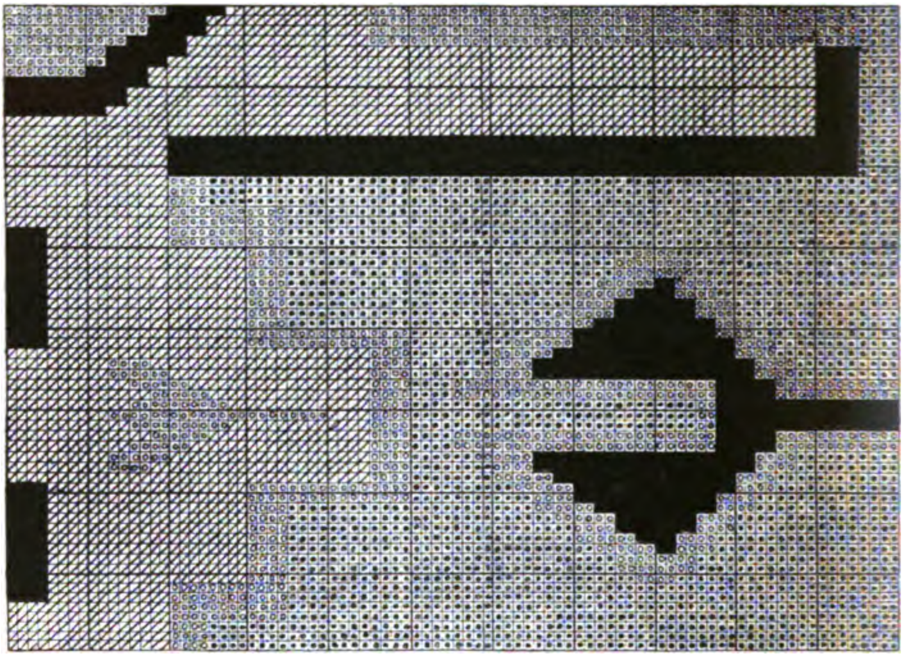

Fig. 223.

plans indicate the weft that is on the surface, and it will be seen in each example that one pick in every group of four picks floats over two pairs of figuring ends

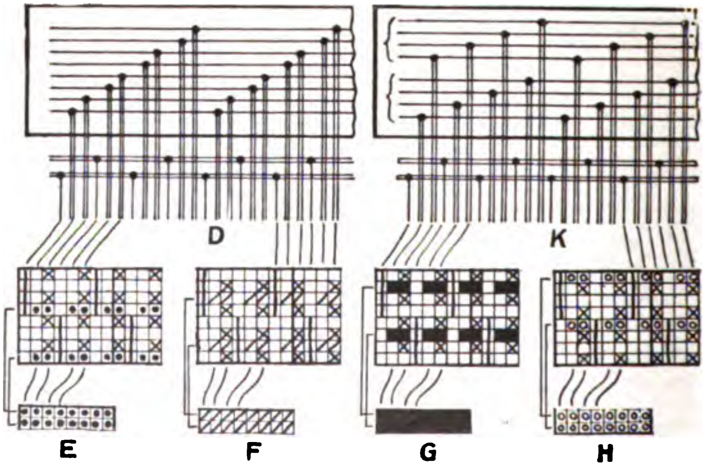

Fig. 224.

and one binding end Similar floats are also formed by one of the wefts on the underside of the cloth, as indicated by the picks in the full weaves upon which there are five blanks to one mark. On the remaining two picks of each group of four, the odd figuring ends are raised and the even ones left down, as indicated by the crosses. Therefore, in every part of the cloth two picks lie in the centre, while one forms figure on the surface and the other a similar figure on the back, the cloth being reversible. Three wefts are much more commonly used than four wefts, but the structure is the same except that there is only one weft in the centre.

In place of the draft given at D in Fig. 224, the sectional harness arrangement, indicated at K, may be employed, in which the odd figuring ends are drawn upon the front, and the even figuring ends upon the rear harness cords. In the latter system the design only needs to be painted out upon half as many vertical spaces as there are figuring ends in the repeat, the cards being cut as follows :—

	Front Section.	Rear Section.
First card.	Cut F, G, and H.	Cut G.
Second card.	Cut E, G, and H.	Cut H.
Third card.	Cut E, F, and H.	Cut E.
Fourth card.	Cut E, F, and G.	Cut F.

With either the draft D or K in Fig. 224 the weft floats are stitched alternately by the binding ends, and a plain weft surface is produced. The cloths, however, are also woven with two binding ends alternating with the figuring ends, as indicated in the draft H, Fig. 213 (p. 194), in which case the weft floats are stitched in a straight line, and a weft-rib surface is formed. Further, in some of the carpet fabrics none of the wefts are in the centre, all except the one forming the figure being interwoven alike on the underside, in the manner illustrated by the tapestry example given in Figs. 211 and 212.

Methods of producing Variety.—Many variations of the carpet styles, illustrated in Figs. 219 to 224, are made chiefly with the idea of obtaining diversity of colour in the design in an economical manner. Worsted, or even jute, figuring ends may be used in the dyed state in forming small parts of a design in conjunction with the figuring wefts. The wefts may be mixed in pairs on the surface and produce effects in addition to those formed in solid colours, in a method similar to that illustrated in Fig. 213 (p. 194).

A cloth may be woven in four colours of weft which is only equivalent in weight to a two-wefted cloth, the first and third colours representing one weft and the second and fourth colours the other weft. Two wefts are brought to the surface together, or one weft in conjunction with the figuring warp, a large variety of intermingled colour effects resulting. For instance, each weft colour can be mixed with the figuring warp colour, and the first and second wefts with either the third or the fourth weft. A combination of eight effects can thus be formed in a design without interfering with the 2-and-2 working of the healds. In painting out a design the different effects may be indicated as represented in the lower portion of the plans A to H in Fig. 225. A, B, C, and D respectively show the first, second, third, and fourth colours intermingled with the figuring ends, alternate spaces being left blank to show where the warp is brought to the surface. E shows the first and third wefts combined ; F, the first and fourth ; G, the second and third ; and H, the second and fourth ; the horizontal spaces being painted alternately in different colours to represent the wefts required on the surface. Two cards are cut from each horizontal space of a design, in each case all but the marks of the weft required on the surface being cut. The complete weaves, in which the marks indicate weft, are shown in the upper portion of the plans A to H in Fig. 225, and in this example two binding ends alternate with two figuring ends.

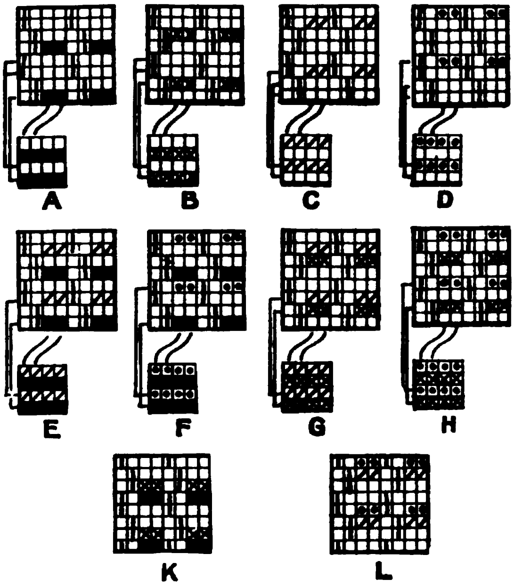

Fig. 225.

It is possible to combine the first and second wefts together, and the third and fourth together, as shown at K and L in Fig. 225, but if these effects are used in a design in addition to the others, the binding ends require to be controlled individually by the jacquard and harness. This is in order that the lifts of the binding ends may be arranged to fit with the order in which the wefts are brought to the surface, as shown in K and L, in which it will be seen that the vertical marks are in different positions from those in the other plans.

CHAPTER XI

FANCY TOILET AND QUILT FABRICS

Fancy Toilet Cloths—Classification of the Fabrics—Loose-Back Toilets. *Fast-Back Toilets and Marseilles Quilts*—Method of Designing—System of Loom Mounting—Four-Pick Structure — Five-Pick Structure — Special Five-Pick Cloth. *Mitcheline or Patent-Satin Quilts*—Method of Loom Mounting—Method of Designing and Structure of the Cloth—Other Varieties of Quilts.

FANCY TOILET CLOTHS

In fancy toilet cloths (which are similar in structure to welts and piques of which they are a development[*]) tight stitching ends, brought separately from a heavily tensioned beam, are woven into a slack plain face cloth in such a manner as to produce a less or more elaborate design according to whether a dobby or a jacquard shedding motion is employed. A simple style is represented in Fig. 226 for which the condensed plan is given at A in Fig. 227. Each mark of A indicates the lift of a tight stitching end over two face picks, by which the slack face cloth is drawn down and indentations formed in the surface; the blank diamond spaces between the marks correspond with the raised or embossed portions of the cloth. In weaving the design A in a dobby loom four healds would be employed for the plain face ends, and nine healds for the stitching ends, as shown in the draft given at B in Fig. 227. In jacquard weaving the plain face ends are drawn upon two healds (or four according to the sett of the warp) placed in front of the harness, only the tight stitching ends being drawn upon the harness, as shown at C in Fig. 227. The draft enables a design to be woven that repeats upon three times as many ends as there are jacquard needles employed. A shows the card-cutting plan for a jacquard machine, the marks being cut.

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[*] Welts and piques are described and illustrated in the accompanying book, "Textile Design and Colour"—"Elementary Weaves and Figured Fabrics."

Classification of the Fabrics.—The cloths are classed as 2-pick, 3-pick, 4-pick, and 5-pick stitch according to the number of picks that each horizontal space of a design represents—that is, the number of picks per stitch; and they are also described as "loose-back" and "fast-back" according to whether the stitching ends are floated loosely or are interwoven on the underside. The bulk of loose-back toilets are made on the 3-pick basis, and a heald-and-harness draft, as represented at C in Fig. 227, is employed for jacquard styles; whereas fast-back cloths are made 4 or 5 picks per stitch, and are woven in a jacquard with working comber-boards.

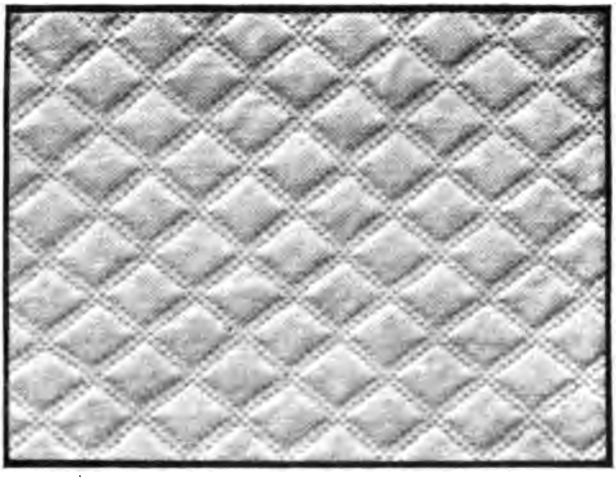

Fig. 226.

Loose-Back Toilets.—Full weaves, to correspond with the plan A, are given at D, E, and F in Fig. 227, which are constructed on the loose-back principle, and are arranged 2, 3, and 4 picks per stitch respectively. In D no wadding picks are inserted, and in jacquard shedding each card acts for two picks, forming the lifts shown in solid marks, while the healds are raised in alternate order by means of tappets so as to produce the plain weave, as represented by the dots.

Generally, thick wadding weft is employed in the cloths which lies between the tight backing ends and the unstitched portions of the face fabric, and gives greater prominence to the latter while making the cloth more substantial. In the 3-pick cloths the picks are usually arranged in the order of 4 face to 2 wadding, as shown at E in Fig. 227, in order that a loom with changing boxes at one end only may be used. In this case, in jacquard shedding, each card acts for three picks, while the healds are raised alternately on the face picks, and both together on the wadding picks ; the latter lifts are indicated by the crosses in E. In a 4-pick structure the picks are arranged 2 face and 2 wadding, as shown at F in Fig. 227, and each card in jacquard shedding acts for four picks. The system of designing for elaborately figured loose-back toilets, which is exactly the same as for fast-back cloths, is illustrated in Fig. 229. Sometimes the 4-and-2 structure, represented at E in Fig. 227, is made what is termed "half-fast" back by raising the stitching ends at rather infrequent intervals on the wadding picks under the embossed figure.

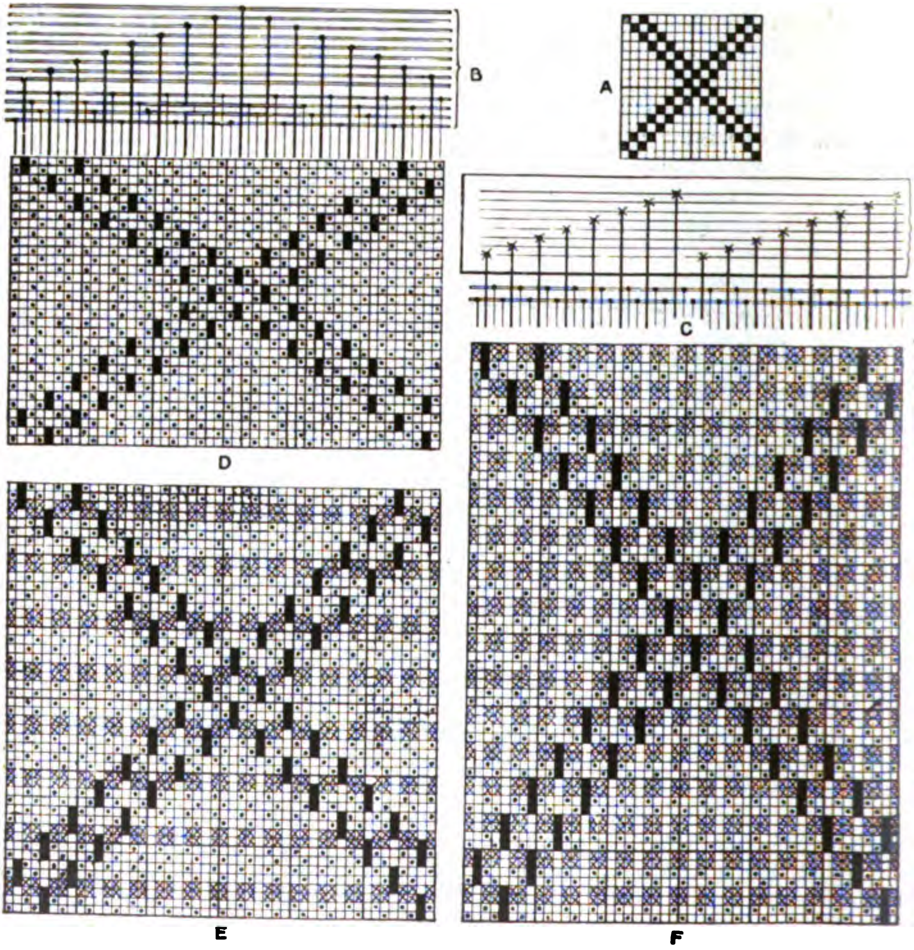

Fig. 227

FAST-BACK TOILETS AND MARSEILLES QUILTS

Fast-back toilet fabrics are exactly the same in principle of construction as Marseilles quilts, which are usually made with either 4 or 5 picks to each stitch or each horizontal space of a design. A representation of a portion of a Marseilles quilt fabric is given in Fig. 228, and a sectional design to correspond in Fig. 229. In this structure the tight stitching ends are interwoven on the underside in plain order with a portion of the picks, so that two plain fabrics are formed—one above the other—in every part of the cloth. In the embossed figure the two fabrics are quite separate from each other, and wadding picks lie between them, but in the ground they are very firmly united by the interweaving of the stitching ends with the face picks.

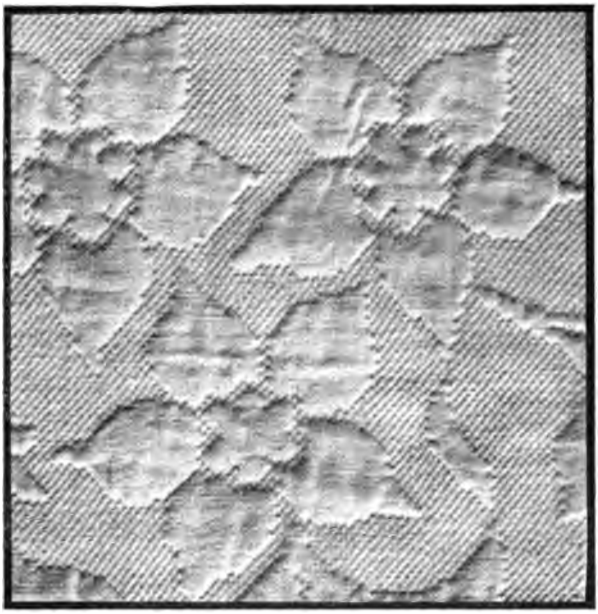

Fig. 228.

Method of Designing.—In preparing a design for the card-cutting the embossed figure may be indicated by a wash of colour, in the manner represented by the shaded squares in Fig. 229, and plain weave is inserted round the figure in order to separate it from the ground. The order in which the stitching ends are required to be interwoven with the face picks is then indicated in the ground of the design, and various small weaves, such as those shown at G, H, and I in Fig. 229, may be employed. In the example shown in Fig. 228 the ground texture is as firm as it is possible to make it, as the stitching ends are raised in alternate order. The ground weave is therefore plain, which, however, only needs to be indicated at the left of the design, as shown in Fig. 229. The card-cutting particulars of the example are :—Cut the ground plain, and miss the figure ; but when a fancy ground is employed, the marks of the ground weave are cut. The stitching ends are left down in the embossed sections of the cloth, lifts only being indicated in the bound portions; and in every part of a design the order of marking requires to be arranged to fit with plain weave.

System of Loom Mounting.—In weaving the cloth a jacquard machine is combined with two working comber-boards and two (or four) healds, and the ends are drafted in the method illustrated at J in Fig. 230. The arrangement very

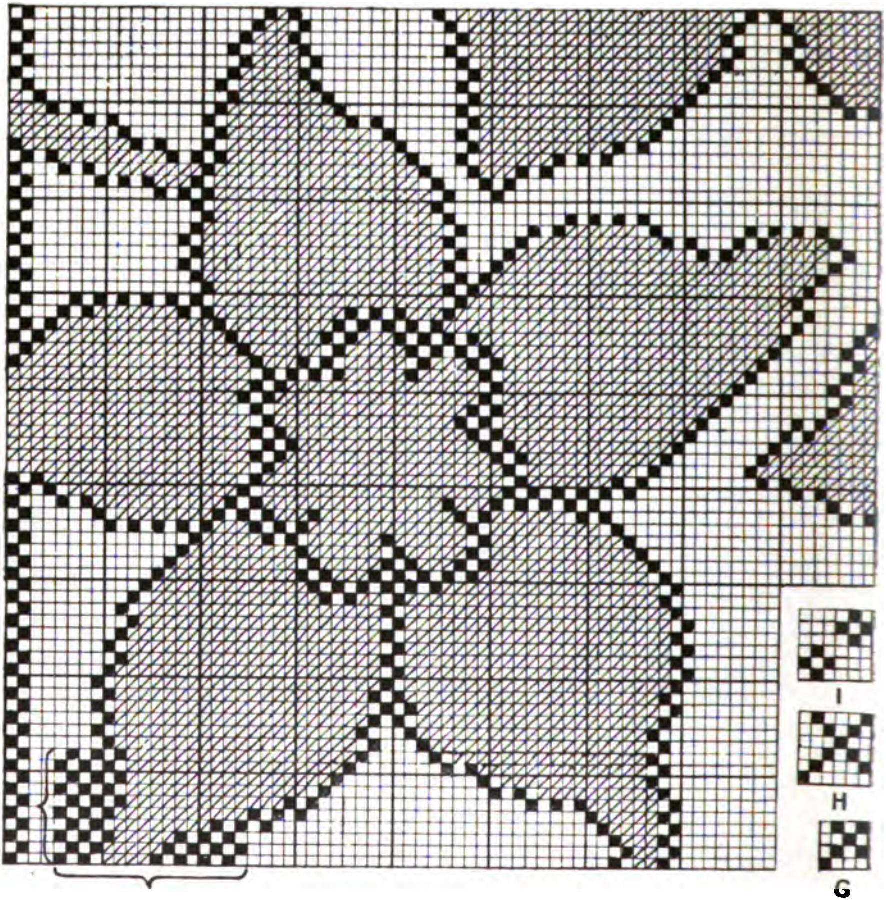

Fig. 229.

largely extends the size of repeat of a jacquard, and a great saving is effected of time, labour, and material in the designing and card-cutting. The ends which form the plain-face cloth are drawn upon healds placed in front of the harness, while the odd and even stitching ends are separately controlled by the harness cords, whose knots rest upon the front and back comber-boards respectively. In order to avoid crossing the harness cords in their passage from the hooks to the comber-board, the needles and hooks are connected in the manner illustrated in the upper portion of Fig. 424, the odd needles controlling the harness cords that pass through one board, and the even needles those that pass through the other board.

Four-Pick Structure.—The plans K and L in Fig. 230, each of which repeats upon six ends and eight picks, respectively show the weaves of the embossed and bound portions of a cloth which is woven with four picks per stitch. The warp is arranged the same as in the pique and toileting structures, and the weft is inserted in the order of two fine picks and two thick picks. The embossed weave K is formed by the operation of the healds and the comber-boards, as follows:—The healds are raised in alternate order on the two fine face picks, so as to form the plain face cloth (represented by the dots), and both together on the thick picks (shown by the crosses), the face ends thus being raised on the wadding and backing picks. The comber-boards are raised in alternate order on the fourth and eighth picks (indicated by the diagonal strokes), the plain back weave thus being formed by the second of each pair of thick picks, while the first of each pair forms the wadding. In the bound weave L, Fig. 230, the order of lifting is the same as in K, but, in addition, the jacquard hooks are raised so as to lift the stitching ends in alternate order over a group of four picks at a place, as shown by the solid marks. The stitching ends are thus raised over the fine face picks, while on the underside they interlace the same with the two thick picks. The tappets which control the healds and comber-boards are made eight picks to the round, and the jacquard is operated once in every four picks.

The complete weave, in the 4-pick structure, is given at M in Fig. 230 of the ends 5 to 20, and the picks 1 to 10 which are enclosed by brackets in Fig. 229. Each card acts for four picks, and, as shown by the diagonal strokes, the alternate lifting of the stitching ends by the comber-boards, where the embossed structure is formed, joins properly with the alternate lifts formed by the jacquard in the bound portions. From a comparison of M in Fig. 230 with F in Fig. 227 it will be seen that the fast and loose-back structures are alike, except that in the embossed portions of the fast-back cloths the tight stitching ends, by means of the working comber-boards, are interwoven in plain order with the even thick picks.

The interweaving of the picks 1, 2, 3, and 4 with the ends 1 to 24 of the design M, is represented at N in Fig. 230, the bound structure being shown on the left, and the embossed effect on the right. O shows the interweaving of the last three ends of M with the picks 9 to 16, the embossed and bound structures being represented in the upper and lower portions respectively. The plain face threads are shown in solid black, and the threads are connected by lines in order that the drawings may be readily compared with the plan M.

The following are the weaving particulars of a cloth with four picks per stitch:—

Face warp, 2/80's cotton; stitching warp, 2/48's cotton; face weft, 30's cotton; wadding and backing weft, 10's cotton; 108 ends and 144 picks per inch. The stitching ends contract from 5 to 8 per cent., and the face ends from 15 to 20 per cent., while the shrinkage in width is about 12 per cent. Since each vertical space of the design paper is equivalent to three ends, and each horizontal space to four picks, the counts of the design paper (not allowing for contraction) is in the ratio of (108 ÷ 3) to (144 ÷ 4)—or 8 × 8 for an 8-row machine, and 12 × 12 for a 12-row machine. Large machines with 12 hooks per row are mostly used in weaving quilts.

The 4-pick structure is sometimes made as shown at P in Fig. 230, which corresponds with the picks 1 to 8, and the ends 1 to 32 of M. In this case the fourth and seventh of each series of eight picks form the backing picks, and the third

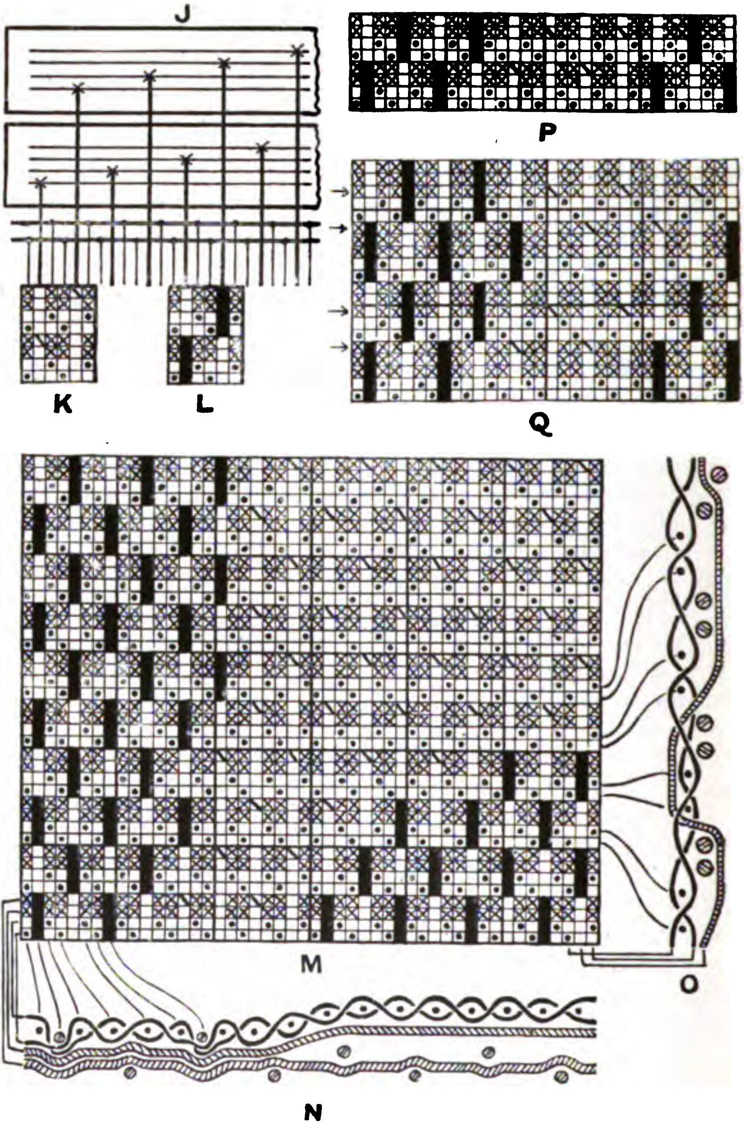

Fig. 230.

and eighth the wadding picks; and the arrangement is used when the backing picks are formed of the same weft as the face fabric. The complete order of wefting is then—2 picks fine, 1 pick thick wadding, 4 picks fine, 1 pick thick wadding, which necessitates the use of a loom that is provided with changing boxes at both ends.

Five-Pick Structure.—The structure of a 5-pick cloth is illustrated at Q in Fig. 230, which corresponds with the picks 1 to 16 and the ends 1 to 32 of M. In this structure in each series of ten picks the fifth and eighth (indicated by the arrows at the side of Q) form the backing picks, and these consist of the same kind of weft as the face picks, so that the complete order of wefting is 2 picks fine, 2 picks thick wadding, 4 picks fine, and 2 picks thick wadding. Each card acts for five picks; the healds are operated in alternate order on two picks, and then are raised together on three picks; and the comber-boards are raised alternately on the pick that follows and that which precedes the wadding picks. To correspond with the foregoing particulars of a cloth the structure represented at Q would be woven with 180 picks per inch, of which 72 fine picks would form the face, 36 fine picks the back, and 72 thick picks the wadding. The system of designing, illustrated in Fig. 229, is correct for both the structures P and Q.

Special Five-Pick Cloth. — In a further development of the Marseilles quilt structure the face and back ends and picks are in equal proportions, and there are two wadding picks to four face and four back picks. A different arrangement of jacquard harness-and-heald mount is employed, which is illustrated at A in Fig. 231. The hooks and needles are connected the same as in an ordinary machine, but two harness cords are attached to each hook, one of which passes through the front comber-board, and the other through the rear board, as represented in the upper portion of the diagram A. The system of tie-up is also illustrated at A in Fig. 234. Two sets of healds are employed, the face ends being drawn upon the front set and one-half of the back ends upon the back set. The other half of the back ends are drawn in alternate order upon the two working comber-boards.

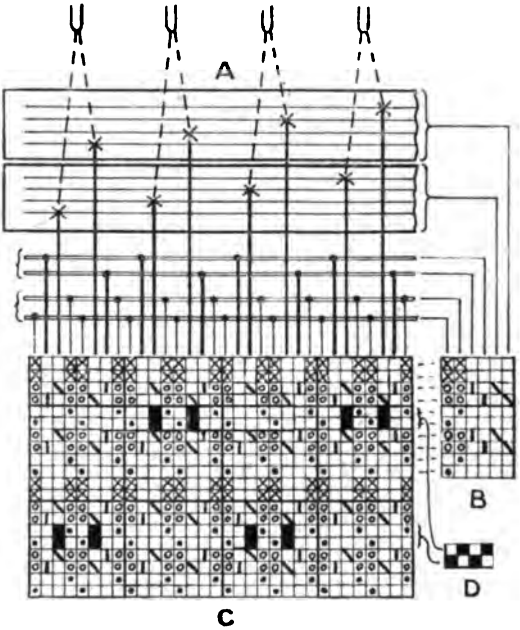

Fig. 231.

The order in which the healds and comber-boards lift, and produce the unbound or embossed portion of the cloth, is indicated at B in Fig. 231. The dots in B represent the plain face weave, the circles the face ends raised on back picks, the crosses the face ends raised on wadding picks, while the vertical and diagonal marks respectively show the lifts of the back healds and the knotted comber-boards, by which the plain weave of the back fabric is produced.

Two repeats of the complete weave of the bound portions of the cloth are given at C in Fig. 231, in which the solid marks show the order in which the harness back ends are lifted over the face picks by the jacquard. Each card acts for ten picks, and the machine lifts on two picks in each group; and as two consecutive harness cords are connected to each hook the harness back ends are raised in pairs.

D in Fig. 231 shows the actual card-cutting plan which, in conjunction with the lifts formed automatically by the healds and the comber-boards, will produce the plan C. The method of designing is illustrated by Fig. 229, but it will be seen in this case that each small space of the paper corresponds to eight ends and ten picks in the cloth. As regards the threads on the face of the cloth each needle is equivalent to four ends, and each card to four picks; and compared with the arrangement illustrated at J in Fig. 230 a saving of three-fourths of the cards is effected, because the figuring capacity of the jacquard is doubled and only half as many cards are required.

In Fig. 231 the picks are arranged 2 face, 2 back, 2 face, 2 back, and 2 wadding, but the principle of the shedding is not limited to this order of wefting. The looms used in weaving the different classes of Marseilles quilts and fast-back toilets are provided with tappets at the side, as illustrated in Fig. 190 (p. 168), for operating the jacquard, comber-boards, and healds, and the tappets are arranged 8 or 10 picks to the round, according to the class of cloth.

MITCHELINE OR PATENT SATIN QUILTS

The Mitcheline quilt structure is a double cloth in which two plain fabrics are so firmly bound together as to be inseparable. The design is due to the interchange of the two fabrics, and the cloth is equally compact and solid in every part. A representation of a cloth is given in Fig. 232, while Fig. 233 shows a portion of the design to correspond, as it is indicated upon design paper. The following are the weaving particulars of a medium quality of cloth :—

Warp—2 ends of 18's cotton to 1 end of 32's cotton.

Weft—2 picks of 40's cotton to 2 picks of 8's soft spun cotton.

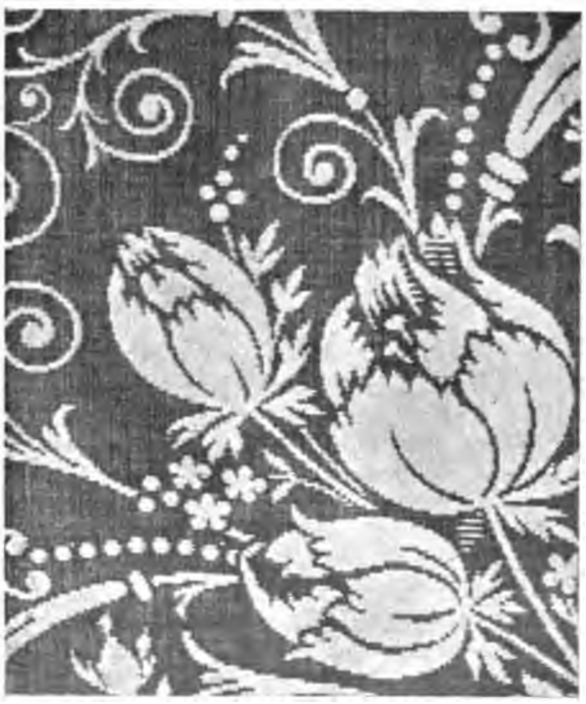

Fig. 232.

64 ends and 96 picks per inch. The 18's warp contracts about 2 per cent., and the 32's warp (which is placed on a separate beam) from 20 to 25 per cent., while the shrinkage in width varies from 10 to 15 per cent.

The 18's warp and the 40's weft form the plain ground fabric, and the 32's warp and the 8's weft the plain figuring fabric, on the right side of the cloth, and *vice versa* on the reverse side. The 32's warp of the plain figuring fabric is really a binding warp which interweaves regularly with the 40's weft of the plain ground fabric, and thus binds the two fabrics solidly together. The cloths are mostly woven grey and then bleached, but sometimes the ends which form the ground (the 18's) are all coloured or are arranged in stripes of white and colour; a white figure then being formed upon a coloured or a striped foundation.

Method of Loom Mounting.—As in weaving Marseilles quilts a combination of two working comber-boards and two healds is employed. The diagram given in Fig. 190 (p. 168) shows the arrangement, and A in Fig. 234 illustrates the principle of the harness tie, while B shows the system of drafting. Two-thirds of the warp threads (the 18's) are drawn upon the harness, and one-third (the 32's) upon the healds, as shown at B. Two harness cords, however, are connected to each hook (as shown also at A in Fig. 231), one cord passing through the front comber-board, and the other through the back board, as shown at A, so that including a heald thread, each hook is equivalent to a group of three threads. By raising a hook, two harness threads—one on each side of a heald thread—are lifted together,

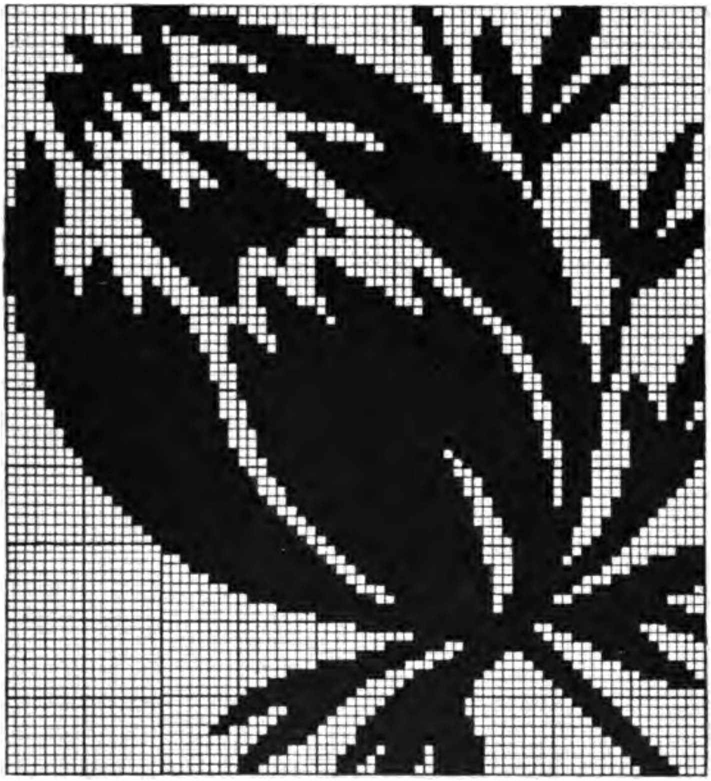

Fig. 233.

but by raising the comber-boards separately, the two harness threads, by means of the harness knots resting upon the boards, are operated independently of each other.

Method of Designing and Structure of the Cloth.—Taking the order of wefting as 2 picks fine (40's) and 2 picks coarse (8's) the order of shedding is as follows :—The comber-boards lift in alternate order on the two fine picks, and form the plain weave represented by the dots in the plans C and D in Fig. 234. The healds lift in 2-and-2 order alternately and produce the weave shown by the crosses in C and D. The jacquard is raised on the first coarse pick and remains up on the second coarse pick and lifts the harness threads in pairs (one on each side of a heald thread), according to the form of design that is required, so that the weave C is formed in one portion and D in another portion of the cloth. The figure is formed chiefly by the floats of the thick weft, and in weaving the cloth right side up the marks in the design given in Fig. 233 indicate harness ends down, or weft. Taking the marks in C and D in Fig. 234 also to indicate weft, the former shows the ground weave and the latter the figure weave on the right side of the cloth ; but in weaving the cloth wrong side up the marks represent warp, and C forms the figure weave and D the ground weave. The blanks, or the marks of the design Fig. 233, are cut according to whether the cloth is woven right or wrong side up. It will be seen in C and D that the healds are raised alternately on the thick picks (the third and fourth in each group), in order to form the plain weave of the figuring fabric. The regular binding of the two cloths together is effected by the alternate lifting of the healds on the fine picks (instead of both being raised, or both left down, which would be necessary in order to form two separate fabrics). On the third and fourth picks the jacquard is raised while the same card presses; then the jacquard is lowered between the fourth pick and the first pick of the

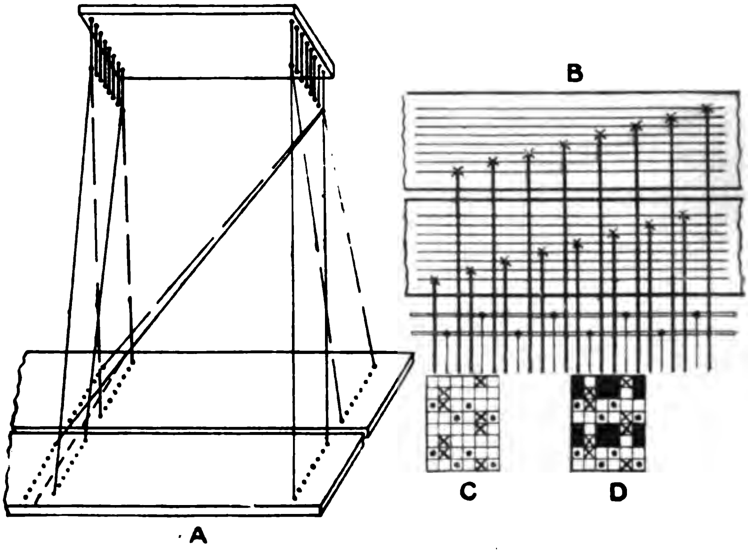

Fig. 234.

next group of four, and the card cylinder is turned in readiness for the following pair of thick picks.

Variations cannot be produced in a design by altering the structure of the cloth, but a subsidiary effect can be woven by painting upon alternate horizontal spaces only, as shown on the left of the small plan given at E in Fig. 235, or the marks of the design may be arranged so as to form a special effect, as indicated on the right of E. The complete weave, to correspond with the picks 1 to 10 of E, is given at F in Fig. 235. Taking the marks to indicate weft, the drawing G shows how the picks 1 and 4 of F interlace with the ends 1 to 24, while H represents the interlacing of the last three ends of F with the picks 1 to 16. In G and H the thick picks and fine ends, which form the figuring cloth, are shown in solid black, in order that they may be distinguished, and connecting lines are indicated to enable the threads to be compared.

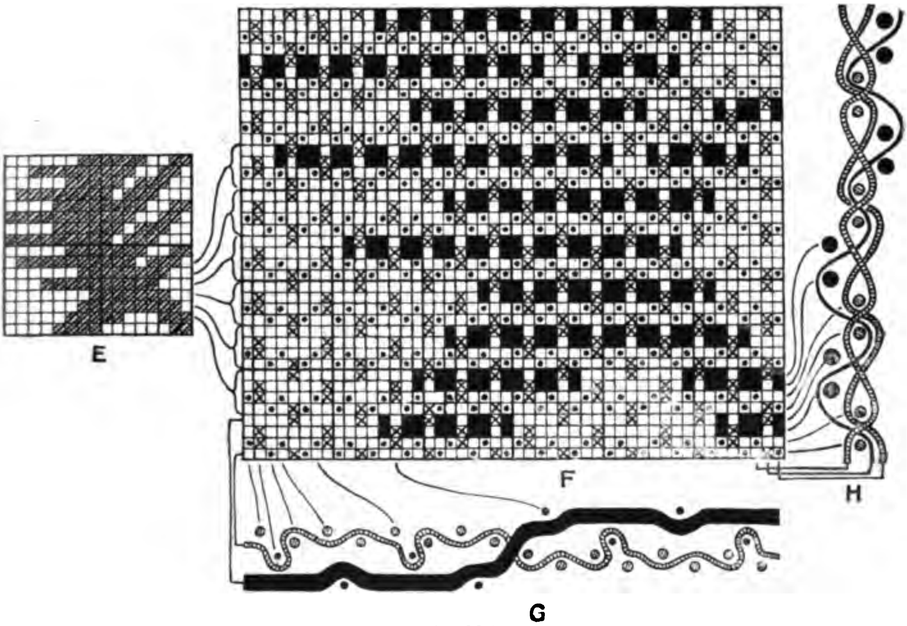

Fig. 235.

The counts of design paper for a cloth counting 72 ends and 96 picks per inch is in the proportion of $(72 \div 3)$ to $(96 \div 4) = 8 \times 8$, or 12×12. On account of each horizontal space representing two thick picks, the figure in coarse cloths has a steppy outline, and in order to avoid this, sometimes a separate card is employed for each thick pick, the operation of the jacquard and the card cylinder being modified to correspond.

Other Varieties of Quilts.—Other forms of quilts are in regular use, such as honeycomb, Alhambra, and rib or rep quilts. Honeycomb quilts are single cloths composed of very thick yarns in which ordinary and Brighton honeycomb and similar weaves are employed, and very frequently these weaves are used in conjunction with warp and weft figure effects. The Alhambra quilt structure is an extra warp figured cloth, and a representation of a fabric is given in Fig. 148

(p. 134), while Fig. 147 illustrates a heald and harness mount that is employed. In a rib or rep quilt the threads are arranged the same as in an Alhambra quilt, and one form of the structure is woven in an Alhambra quilt loom. In this type all the figuring ends are raised on one pick, and all the ground ends (by lifting the healds together) on the next pick. Also, on the picks on which the ground ends are lifted, the harness ends are raised where the figure is formed, the lifting of both series of ends causing long weft floats to be produced under the figure. In another form of rib quilt a warp figure is produced on both sides of the cloth on a plain rib ground. The inverted hook type of jacquard, illustrated in Fig. 186 (p. 161) is used, and the cloth is similar in structure to the example given in Fig. 187 (p. 162), but on account of the thick weft and small number of picks per inch that are employed in the structure, it is customary to use a separate card for each pick. In addition, a cloth is largely used for bed mats that consists of a plain foundation which is figured with coloured extra weft, the surface being almost entirely covered by the figuring floats.

CHAPTER XII

GAUZE AND LENO FABRICS

Structure of the Cloths. *Gauze Mounting*—The Doup—Bottom and Top Douping—Gauze and Leno Drafting—Relative Position of Healds—The Easer or Slackener—Sheds formed in Doup Weaving—Construction of Lifting Plans—The Shaker Motion—Gauze and Leno Compared—Modifications of Pure Gauze and Leno. *Combinations of Gauze and other Weaves*—Stripe Patterns—Cellular Tennis Shirtings—Russian Cords—Simple Cross-over and Check Gauze Effects. *Simple "Net" Lenos*—Comparison of Top and Bottom Doup Pegging Plans—Denting Net Lenos—Designing Net Lenos and Features to Note—Production of Pattern by Varying the Lifts of the Standard Ends—Bead Mounting for Net Lenos. *Combinations of Gauze and Leno with Extra Warp and Extra Weft Effects. Two or More Doup Patterns. Patterns produced by one Doup and two or more Back Crossing Healds*—Comparison with Two-Doup Style—Construction of Heald-Knitting Plans for Gauze Stripes—Fancy One-Doup Net Leno—Distorted Weft Styles—Gauze and Figure Weave Combinations.

Structure of the Cloths.—In gauze and leno weaving certain ends—termed crossing ends—are passed from side to side of what are termed standard ends, and are bound in by the weft in these positions. The crossing and standard ends may be arranged with each other in various proportions, as 1-and-1, 1-and-2, 1-and-3, 2-and-2, 2-and-3, etc., but an essential condition is that each group of crossing and standard ends must be placed in one split of the reed. A crossed system of interlacing can be obtained when all the warp is brought from one beam, and in some cases this is essential in order to produce the desired effect. Very frequently, however, there is such a difference in the take up that it is necessary for the two series of ends to be brought from separate beams. The warp may consist entirely of crossing and standard ends, or stripes of these may be combined with stripes in which the ends interlace in the ordinary manner so as to form plain, twill, figure, etc. It is also possible for the crossing and standard ends to form the crossed interlacing alternately with straight interlacing in any required order. There is, therefore, almost unlimited scope for the production of variety of effect in striped, checked, and figured fabrics by combining gauze or leno with practically any other system of interweaving. Where the crossed interlacing occurs, an open, perforated structure may be formed, or the crossing ends may be interwoven in zig-zag form on the surface of a more or less compact ground texture. Nearly all kinds of yarns and yarn combinations can be used, but in open perforated structures particularly the threads should be as smooth, as uniform in thickness, and with as little loose fibre on the surface as possible. Silk threads, being the smoothest, are the best, but cotton is very suitable, especially when mercerised, and also linen, as these yarns possess little loose fibre; while worsted yarns, when made from a good quality of wool and hard twisted and gassed, yield clear effects. Colour may be introduced to form stripes and checks, and various fancy yarns, such as printed, knopped, spiral, gimp, slub, etc., may be inserted at intervals either as crossing, standard, or ground ends, or in the weft, in order to give a special effect. The crossing ends require to be of good quality; and very light gauze fabrics are sometimes given the requisite firmness by using stiff linen or polished cotton yarn as weft.

GAUZE MOUNTING

The necessary additions to an ordinary shedding arrangement consist of a half-heald—termed a doup or slip—which is connected with an ordinary heald or harness, and an easing or slackening motion, while in some cases a shaker motion is required.

The Doup.—In Fig. 236 the different types of doups which are in most general use are represented, A and B showing two methods of connecting the half-heald to an ordinary heald, while C shows how it is connected to a jacquard harness. The crossing ends pass through the loops of the half-heald where indicated by the dots, and in the direction shown by the arrows; and it will be noted that while in A and B the half-heald is permanently connected to the ordinary heald, in C the loop is held in position by the warp thread. The first method is more convenient in drawing in the warp and in repairing broken ends. The advantage of the latter method is that the doup, which wears out much more rapidly than the harness, can be readily replaced; but, on the other hand, if the crossing ends are absent, the loops will slip out of the mail eyes. During weaving, however, this is not very detrimental, as when the loose slip is used it is customary to have two crossing ends passing through each loop, both of which must be broken before the loop can detach itself from the harness. In Fig. 236 the half-heald is shown with a lath only at the bottom, but frequently a lath is also provided at the top, which is connected near each end to the bottom lath by means of cords, the arrangement, however, being simply in order to facilitate connections being made to the shedding apparatus.

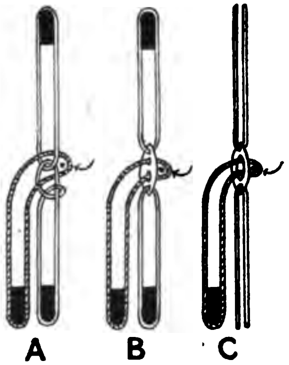

Fig. 236.

Bottom and Top Douping.—The half-heald may be placed with the lath below the warp, as shown in Fig. 236, and in the diagrams in Fig. 237, or above, the position in the latter case being represented by Fig. 236 when turned the other way up, and by the diagrams in Fig. 237A. Bottom douping is more commonly employed, as it is simpler to follow, is more conveniently applied in the loom, and the lift is not so heavy. This method, however, makes it necessary for certain styles to be woven wrong side up. In top douping the parts are better under the observation of the operative, and the repairs to the half-heald are more readily effected; but if a loop breaks, as it hangs down, it is liable to become entangled with the warp and cause breakage, while the tension on the crossing ends, when a spring-reversing motion is used, makes it difficult in some cases to get a level bottom shed line. In practice the use of the top doup is generally limited to styles which require to be woven right side up, and can only be thus produced with the top doup. For some patterns which require two doups it is found advantageous to use both methods together.

In bottom douping the half-heald is invariably placed in front of the ordinary heald to which it is connected, as shown in Fig. 237; but in top douping it is sometimes placed in front and sometimes behind, the latter position being shown in the diagrams in Fig. 237A. The choice of the position in top douping is largely a matter of opinion, the advantage claimed for placing the half-heald behind being that the relative position of the parts is then the same as in bottom douping with the half-heald in front.

Gauze and Leno Drafting.—For the simplest style of doup weaving the following healds are necessary:—A half-heald or doup, lettered D in Figs. 237 and 237A; a front-crossing heald F, to which the doup is attached; a back-crossing heald B, through which the crossing ends are drawn; and a standard heald S, which carries the standard ends. (In practice the terms very largely used for the healds are respecttively—Doup, front standard heald, back standard heald, and standard heald, or sometimes ordinary heald. It is considered that the former designation is less liable to lead to confusion, the term standard being used only for the healds which carry the standard ends, crossing for the front and back healds which operate the crossing ends, while ordinary will be applied to healds which are not used for the douped effect, but to produce some other weave.) G in Fig. 237 shows a bottom doup draft in which one end crosses one end. In drawing in the warp the ends are drawn through the back crossing heald B and the standard heald S in the ordinary manner. Then the front crossing heald F and doup D are placed in front, the standard ends are drawn between the leashes of F, while each crossing end is passed under the standard end and drawn through a loop of the doup D. In top-douping the crossing ends are passed over the standard ends, as shown at K in Fig. 237A. The crossing ends may cross the standard ends either from the left or from the right. No ends are drawn through the mails of the front crossing shaft, the purpose of this heald being simply to support the half-heald.

Relative Position of the Healds.—In mounting the healds in the loom, in order to reduce the acuteness of the angle formed by the crossing warp when the crossed shed is made (shown at H and L in Fig. 237 and 237A) it is customary to allow a greater amount of space between the front and back crossing healds than between the other healds. In the drafts G and K in Figs. 237 and 237A the back crossing heald is shown next behind the front crossing heald. The position is a matter of opinion, and by some it is preferred to have the back crossing heald behind all or a portion of the other healds, as the further back it is placed the less acute is the angle formed by the crossing ends when the crossed shed is made, and there is, therefore, less strain on the crossing warp. However, so long as sufficient space can be obtained between the back and front crossing healds, the former may with advantage be placed next behind the latter, as then there is no liability of friction and entanglement of the crossing ends with the leashes of the other healds. When the design necessitates the use of all the shedding levers of a dobby, and the space between the healds is thus limited, it is better for the back crossing heald to be placed behind a few of the ordinary healds, or otherwise the angle formed by the crossing ends will be too acute (see further reference, p. 243).

The Easer or Slackener.—This consists of a bell crank lever A fulcrumed at C, one extremity of which supports a cylindrical bar E, Figs. 237 and 237A, which extends across the width of the warp, while the other end is connected to the shedding apparatus. After the healds have been mounted in the loom the easing bar is placed with the crossing ends passing in contact with its surface (over or under according to the position of the crossing warp beam), and usually in a position further back than the back rest. The crossing ends thus have a longer stretch than the other ends, and when the lever A is operated the bar E moves inward and gives in a sufficient length of the crossing ends to compensate for the greater length required when they form the shed in the crossed position. The lever is returned to its normal position by means of a spiral spring, and as in many cases the tension on the crossing warp makes it necessary for a very strong spring to be used, it is advisable for the easer to be arranged to give off the required length of warp with as little movement as possible. As many easers are required as there are doups employed, and several warp beams may be necessary, a proportion of which may be placed lower and the remainder higher than the back rest; but the crossing ends, after leaving the easing bars, should be passed in contact with rods which will guide them all to the lease rods in line with the other warp threads.

Sheds Formed in Doup Weaving.—These are illustrated for bottom douping at H, I, and J in Fig. 237, and for top douping at L, M, and N in Fig. 237A. The formation of the *crossed* shed, which is the chief feature in doup weaving, is shown at H and L in the two figures. When this shed is formed the crossing ends are moved out of their normal position to the opposite side of the standard ends. In bottom douping the doup D and the front crossing heald F are raised, and the back crossing heald B and the standard S are left down, as shown at H; while in top douping the position of the healds is exactly the reverse, as shown at L. The crossing ends, being held by the back crossing heald in one line of the shed, and by the doup and front crossing heald in the other line, pass almost at right angles from one to the other; hence a greater length of crossing warp is required from the fell of the cloth to, say, the lease rods than when these ends are in the normal position. The easer A is, therefore, operated at the same time as the front crossing heald, and the easing bar E is moved in from the position represented by the dotted circle; the additional length of crossing warp required thus being given in.

The formation of the *open* shed, in which the crossing ends are operated in their normal position, is illustrated at I and M in Figs. 237 and 237A. In bottom douping the doup D and the back crossing heald B are raised, and the front crossing heald F and the standard S are left down; the loops of the doup being drawn under the standard ends and lifted with the crossing ends when the latter rise on the normal side of the standard ends, as shown at I. In top douping exactly the opposite conditions prevail, as shown at M. When this shed is formed the lever A is depressed and the easing bar E is moved outward, the stretch of the crossing warp thus being increased to the normal.

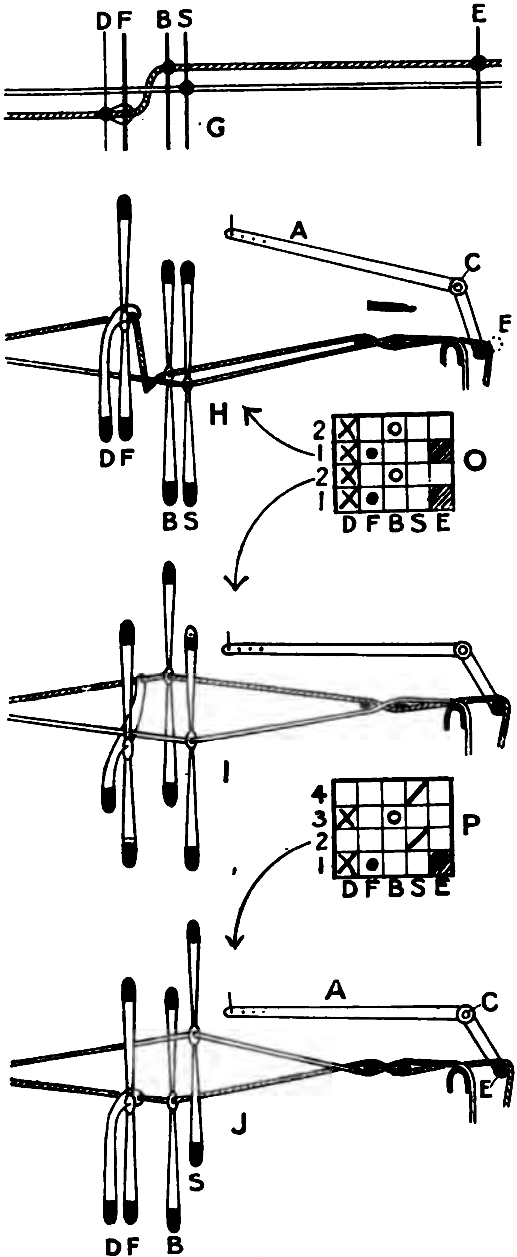

Fig. 237.

J and N in Figs. 237 and 237A show the formation of an ordinary shed in which the standard heald only is raised in bottom douping, while only that heald is depressed in top douping. The easing bar E is again in its outward position.

The correct setting of the doup is of the greatest importance as regards the prevention of broken ends and undue wear of the loops. Its height should be carefully regulated, and it should move exactly in accordance with the movements of the front and back crossing healds. Thus, in bottom douping, if it is not raised sufficiently the loops will drag on the crossing ends, or on the leashes of the front crossing heald. On the other hand, if it is raised too high the loops will slide through the eyes of the front crossing heald when the cross shed is formed, while they will hang slack and be liable to become entangled on the open shed. Also, in order to facilitate the crossing movement, the standard heald should be set slightly higher in bottom douping and rather lower in top douping than the healds which operate the crossing ends.

Construction of Lifting Plans.—O and Q in Figs. 237 and 237A show the lifting plans for bottom and top douping respectively when the crossed and open sheds are formed alternately, the picks numbered 1 in the respective plans corresponding with the drawings shown at H and L, and those numbered 2 with I and M. The plans P and R similarly show the order of lifting when an ordinary shed is formed between the crossed and open sheds, the picks numbered 1 respectively corresponding with H and L, 3 with I and M, and 2 and 4 with J and N. The crosses represent the lifts of the doup, the dots of the front crossing heald, the circles of the back crossing heald, and the diagonal strokes of the standard, while the shaded squares show when the easer is operated. It will be noted that four spaces, D, F, B, and E, are provided for showing the operation of the crossing ends. The easer is always moved when the front crossing heald is brought into action, while the doup is operated with both the front and the back crossing healds. In practice, therefore, the lifts of the easer and the doup are frequently omitted from the lifting plan, as the other marks of the plan readily indicate when these should be operated. Also, in order that there will be absolute certainty of the movements being in unison, in bottom douping especially, the easer is sometimes connected to the shedding lever that controls the front crossing heald; while the lath of the half-heald is connected to the back crossing heald lever, and also by cords to the lath of the front crossing heald on the opposite side of the shed.

The Shaker Motion. — This mechanism is required under certain conditions in both bottom and top douping. From an examination of the crossed and open sheds, shown respectively at H and I in Fig. 237, it will be seen that the front and back crossing healds change positions in forming the sheds, but the standard is at the bottom and the

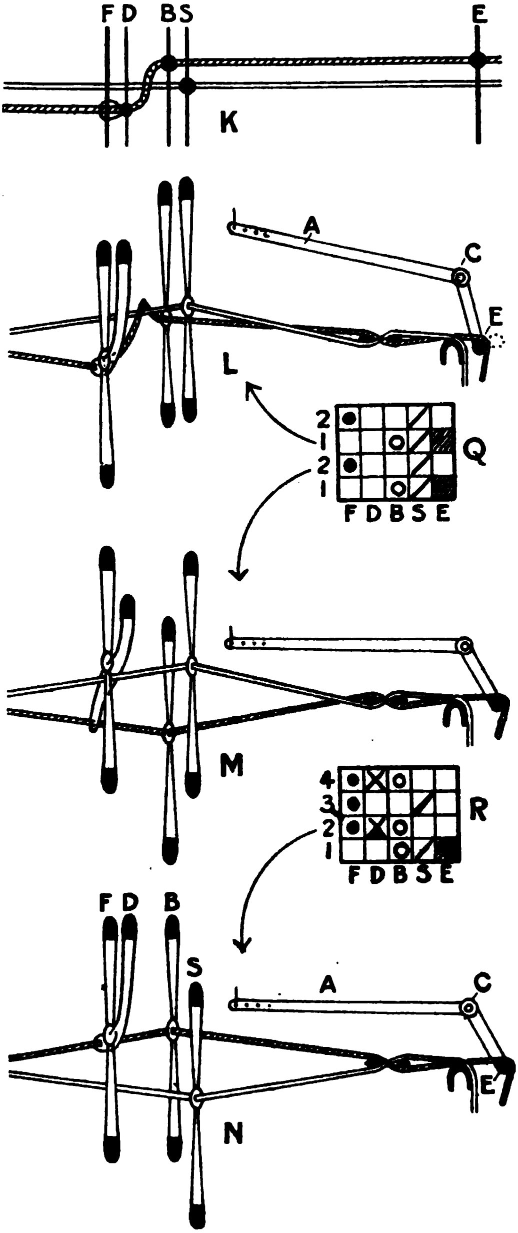

Fig. 237A.

doup at the top in both cases. In an open or a semi-open shedding motion, in changing from one shed to the other, the front and back crossing healds move simultaneously, and the mail eyes thus pass each other in the centre. At this time the crossing ends, and with them the loops of the doup, have to slip under the standard ends from one side to the other. In the first place, therefore, it is clear that the doup should be lowered to the centre along with the heald that is being depressed, and then be taken back to the top along with the heald that is being raised. This movement of the doup can be readily arranged for, even when it is operated separately in a double-lift open-shed dobby, by connecting it to two jacks, and arranging the pegging to allow one to fall and the other to lift. The next point to consider is the position of the standard ends which, so far as regards the interlacing of the threads, do not require to be raised at all. Assuming that the standard heald is stationary at the bottom—at about the centre of the movement in an open or a semi-open shed, the parts will occupy the position represented at T in Fig. 238, where the front and back crossing healds are shown nearly level. It is evident that the crossing ends, and with them the loops of the doup, in changing from one side to the other of the standard ends, will drag against the latter, and excessive strain will be put upon the warp. In addition, if the easer is operated from the ordinary shedding arrangement, the easing bar will be about midway between its two extreme positions, as shown in the diagram T; and when the crossing takes place the length of the crossing warp will be insufficient to reach under the standard ends. The formation of a shed, under the conditions shown at T, is clearly impossible. If, however, the standard heald is raised half-way, or a little higher, at the time that the front and back crossing healds are passing each other in the centre, there will be no obstacle to the crossing ends and the loops passing from one side to the other of the standard ends, as is represented at U in Fig. 238.

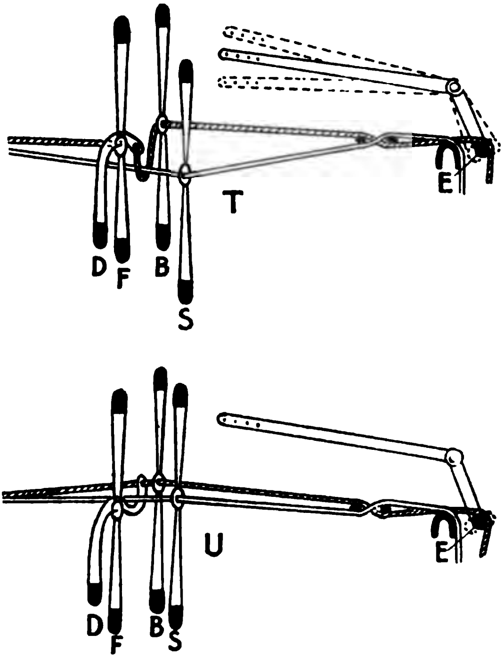

Fig. 238.

It is for the purpose of raising the standard ends to the centre of the shed and of returning them to the bottom when the crossing has been effected that a shaker motion is employed. The additional mechanism is only required when, in an open or a semi-open shedding motion, the crossed and open sheds, or *vice versa*, are formed on successive picks, on both of which the standard ends are down. This, of course, is in reference to bottom douping, but the same applies in open shedding to top douping, except that the standard ends require to be moved from the top to the centre and back again by the shaker. The shaker motion may be dispensed with (1) when one or more picks separate the crossed and open sheds, because then the doup and the front and back crossing healds are level before the crossing commences ; (2) when the crossed and open sheds succeed each other so long as the healds, which govern the crossing and standard ends, are all level between the picks. The latter condition may be due either to the type of shedding motion employed or to the order in which the standard ends interlace. Thus no shaker is necessary—(*a*) in closed shedding, as all the healds are level between the picks ; (*b*) in top douping in double-lift semi-open shedding, as the shafts required up on successive picks are lowered to the centre between the picks ; (*c*) in double-lift open and semi-open shedding, when in each group there are two or more standard ends which work plain, as in this case the two standard healds are in the centre at the same time as the front and back crossing healds. Sometimes, however, and particularly when the standard ends are somewhat crowded, shaking, in a modified form, is employed when not absolutely necessary ; but the idea here is not so much to move the standard ends half the height of the shed as to shake them sufficiently to enable the crossing from one side to the other to be more readily effected.

The half-lift of the standard ends is obtained in various ways, but usually a motion is more readily applied to bottom than to top douping. It is necessary to keep in mind that the standard ends, in addition to being moved by the shaker, may require to be operated by the ordinary shedding mechanism. As a general rule, in order to simplify the mechanism, the shaking is effected on every pick, whether required or not, and the standard ends may thus receive an undue amount of vibration. In tappet weaving the half-lift is obtained from a specially shaped double-winged tappet, and in dobby weaving the loom is sometimes fitted with a shaker tappet and the necessary connections. In another method the shaking movement is obtained by means of suitable connections from the crank arm of the loom ; whilst most makers now provide special attachments to double-lift dobbies for the purpose. In top douping in a double-lift open shed dobby, a simple arrangement consists of connecting the standard heald to two contiguous jacks, both of which are pegged to lift when the standard is required to remain at the top, while when the half-movement is necessary, one is pegged to fall and the other to rise, the shaking thus being done only when required.

Gauze and Leno Compared.—The terms gauze and leno are frequently used synonymously to designate any fabric in which the doup principle of weaving is employed. Sometimes, however, the term gauze is applied to fabrics in which the crossed interweaving produces a light perforated fabric, while leno is used to distinguish heavier styles in which the crossing ends form a distinct zig-zag effect on the surface of the cloth. Again, the term gauze is sometimes applied to those fabrics in which the crossing ends pass from one side to the other of the standard ends on succeeding picks, in contradistinction to which the term leno is used for styles in which one or more picks are inserted between the successive movements of the crossing ends. The last system of classification is useful, since it very largely serves to distinguish doup fabrics which, when produced on the double lift shedding principle, require a shaker motion, from those for which such a mechanism is unnecessary.

A typical open or perforated gauze structure, in which one crossing end passes from side to side of one standard end on succeeding picks, is illustrated in Fig. 239. A corresponding flat view is given at H in Fig. 240, and the interweaving of the threads is represented in section at K; while G shows the draft for a bottom doup, and O the lifting plan. The crossing ends, represented in solid black, are raised over the weft on every pick—on the right of the standard ends on the odd picks by the lifting of the front crossing heald and doup, and on the left on the even picks by the lifting of the back crossing heald and doup. The standard ends are under the weft on every pick, but they lie above the crossing ends between the picks. In top douping, the positon of the threads is exactly the reverse, and the crossing ends would then be represented by the shaded lines, and the standard ends by the solid lines in H.

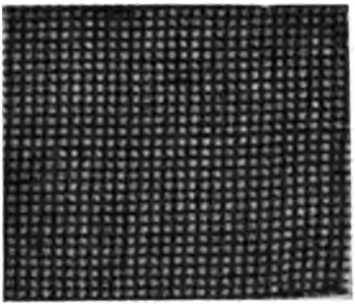
Fig. 239.

If both the crossing and standard ends are brought from one beam, the ends will bend equally, as shown at H in Fig. 240; but if the two series of ends are brought from separate beams, the standard ends may be arranged to lie straight in the cloth while the crossing ends do all the bending, as shown at I in Fig. 240. Although H and I are exactly alike as regards the interlacing of the threads, the woven structures appear quite different, and, in addition, more picks per inch can be inserted in the latter method than in the former.

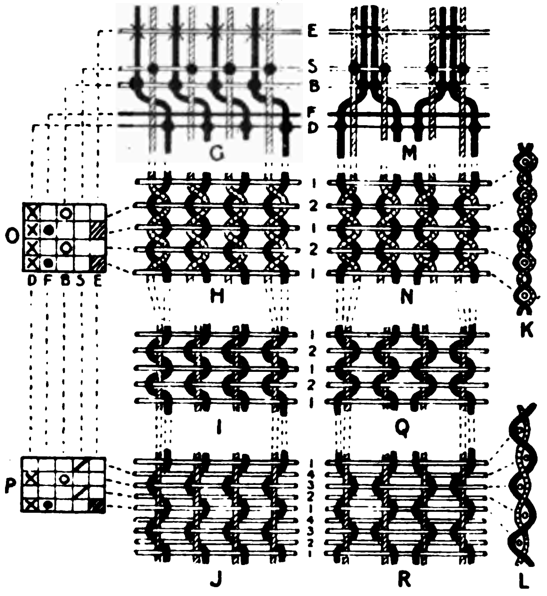

Fig. 240.

The flat view given at J and the section at L in Fig. 240 illustrate a typical leno style for which G is the draft and P the lifting plan. The crossing ends are lifted on the odd picks only—first on the right and then on the left of the standard ends—while the latter work plain, and are under the odd and over the even picks. This structure is much more readily wefted than is the case in either H or I.

By comparing the diagrams on the left of Fig. 240 with those shown in Fig. 237, it will be seen that the draft G and the lifting plans O and P in the two figures respectively coincide. The structure shown at H in Fig. 240 is produced by the alternate formation of the crossed and open sheds represented at H and I in Fig.

237, and in an open-shed machine the standard ends require to be lifted by a shaker between the picks. In producing the structure shown at J in Fig. 240, an ordinary shed, such as is indicated at J in Fig. 237, is formed between the crossed and open sheds, and a shaker motion is unnecessary in this case.

Modifications of Pure Gauze and Leno.—A simple modification of the pure gauze and leno structures is obtained by pointed drafting, in which the crossing ends are drawn under (or over) the standard ends alternately to left and to right, as shown at M in Fig. 240. With the lifting plan O the structure represented at N may be formed by bringing all the warp from one beam. The crossed and open sheds are formed alternately, and the ends interlace as shown at K, but each pair of ends is turned the opposite way to the adjacent pairs. The pattern may be made more effective by using a special yarn for the crossing warp and bringing it from a separate beam, thus forming the structure represented at Q. With the draft M and the lifting plan P in Fig. 240 the structure illustrated at R results, the pairs of ends interweaving as shown at L, but turned in opposite directions. The fabric represented in Fig. 241 corresponds with the structure shown at R.

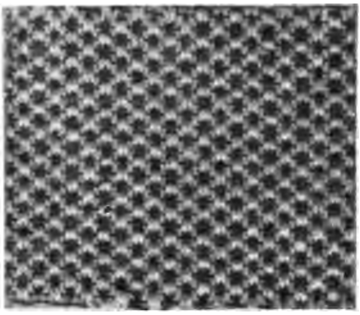

Fig. 241.

Variety of effect is chiefly obtained in the pure gauze and leno weaves by combining threads in both warp and weft, which are different in thickness, colour, or material, and, by varying the denting of the warp threads; very interesting stripe, cross-over, and check patterns being produced.

COMBINATIONS OF GAUZE AND OTHER WEAVES

Stripe Patterns.—The next system of ornamentation consists of combining gauze or leno—one crossing one—with plain or other weave in stripe form. In these styles the gauze portion is frequently made two or more picks in a shed in order that sufficient picks may be inserted to obtain a good structure in the ordinary weave. Also, in order to secure the necessary openness in the doup section and density in the ordinary weave, the latter may be made two or more times finer in the reed than the former. A stripe consisting of gauze (in which one end crosses one end with two picks in a shed) and plain cloth is shown in Fig. 242. A flat view of a portion of the structure is given at A in Fig. 243, while B shows the system of drafting, four healds being allowed for the plain stripe. In the lifting plan given at C the lifts of the easer are not indicated, but the doup is shown raised,

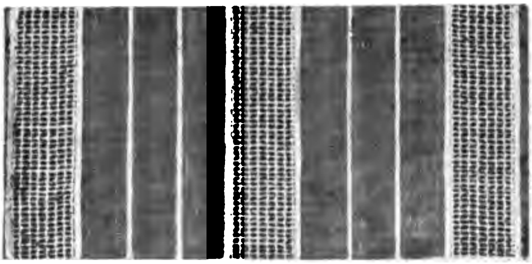

Fig. 242.

and the standard heald depressed on every pick, while the front and back crossing healds are lifted on two consecutive picks alternately. The order of denting is indicated below B, the ends being placed two per split, but in the gauze stripe a split is missed between the pairs of ends. In order to obtain a clear edge to the plain stripe, however, no split is missed between the gauze and the plain.

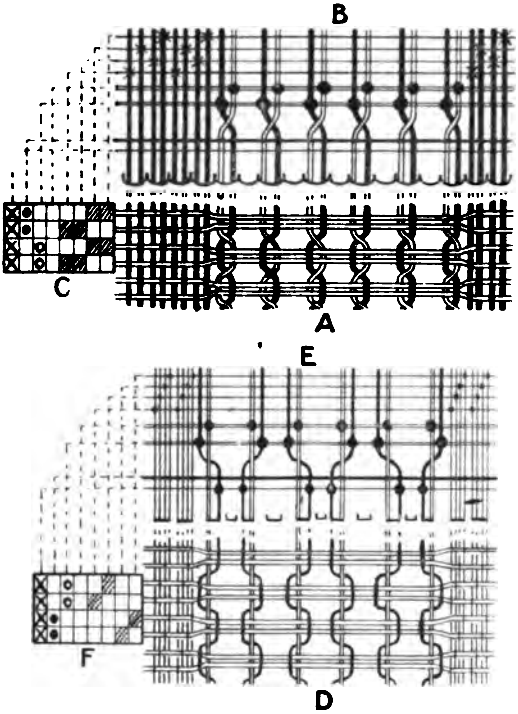

Fig. 243.

Cellular Tennis Shirting.—This class of fabric is largely ornamented on the foregoing principle, and an illustration is given in Fig. 244 in which the typical cellular structure is combined with a 3-and-1 warp twill stripe. A sectional drawing. corresponding with the pattern, is given at D in Fig. 243, which shows how the threads interweave as viewed from the wrong side of the cloth. To weave the cloth right side up, a top doup is necessary; but as this causes the lift to be very heavy, it is convenient to use a bottom doup and weave the cloth wrong side up. The draft for the bottom doup is shown at E in Fig. 243 with the order of denting indicated below—the twill stripe being dented 4 ends per split, and the gauze stripe 2 ends per split, with a split missed between the pairs of ends—while F shows the lifting plan. The following are suitable particulars for the cellular structure:—2/20's cotton warp, 30 ends per inch; 18's cotton weft, 40 picks per inch. As the standard ends lie almost straight in the cloth only about 104 yards of standard warp, compared with about 150 yards of crossing warp, are required for 100 yards of cloth. The shrinkage in width is about 10 per cent.

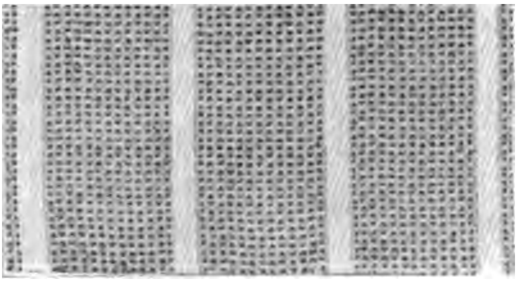

Fig. 244.

Russian Cords. — Fig. 245 shows a gauze and plain stripe—termed a Russian cord—in which the idea is not to produce an open structure by means of the doup, but to form solid vertical lines which are in strong colour contrast with the ground. A crossing end is passed on succeeding picks from side to side of a thick standard end, which is similar in colour to the crossing end; or there may be several of such standard ends working together as one, as represented on the right of Fig. 245, which shows the standard ends with the crossing end removed. The flat view given at G in Fig. 246, which corresponds with the pattern, illustrates the principle of construction, the effect being represented, for convenience, as viewed from the right side of the cloth. To weave the fabric right side up a top doup is required, and the draft with the doup in front of the front crossing heald is then as shown at H in Fig. 246, and the lifting plan as at I; and it will be noted that the order of lifting for the gauze effect is the same as is illustrated at Q in Fig. 237A in reference to the formation of pure gauze in top douping. A comparatively large number of picks per inch are inserted, and as the standard ends are bulky, bold horizontal traverses of the crossing ends are made at frequent intervals. Heavy cord lines are thus produced which, on account of the contrast in colour with the ground warp and weft, appear to be formed in extra weft. The crossing warp requires to be very much longer than the standard warp, and in the example is about four times as long, but the proportionate lengths vary according to the reed and picks of the cloth, and the bulkiness of the standard ends. Variety of effect is sometimes given to these styles by having the standard ends different in colour from the crossing ends, and ceasing to form either the crossed or the open sheds for a number of times in succession. The thick standard ends are thus left uncovered by the crossing ends for a space, the latter lying straight in the cloth and being practically concealed by the former, hence the continuity of the coloured line is broken by spots of another colour.

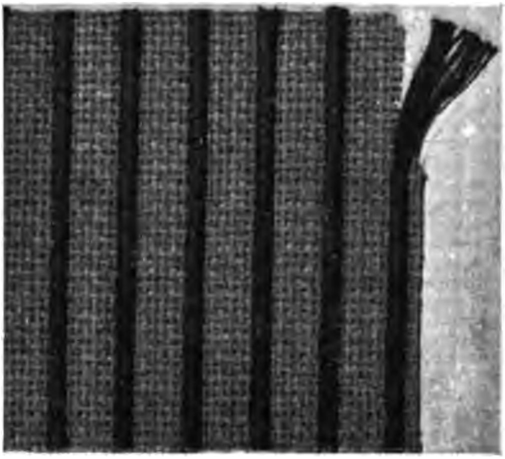

Fig. 245.

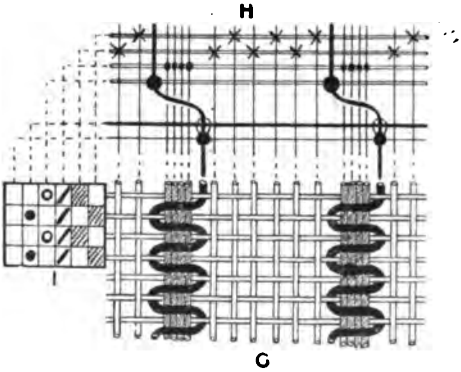

Fig. 246.

Simple Cross-over and Check Gauze Effects.—The next development, on the draft-one crossing one, is the combination of gauze and plain weave to form cross-over effects, as shown in the pattern in the upper portion of Fig. 247; or, by suitably arranging the denting, to form check effects, such as is illustrated by the pattern in the lower portion of the figure. A flat view, to correspond with the upper pattern, is given at A in Fig. 248, in which the picks are shown in groups of five, the weft threads being readily inserted towards each other where the weave is plain, but clearly separated where the crossing is made. The draft is given at B, and the lifting plan at C in Fig. 248, and it will be seen that the plain weave is formed by the standard heald lifting alternately with the doup and back crossing heald on the picks 1—5, and with the doup and front crossing heald on the picks 6—10. Plain weave may thus be formed in two ways on the draft B, and it will be shown that the second method is the foundation upon which many elaborate figured gauze styles are produced with one doup.

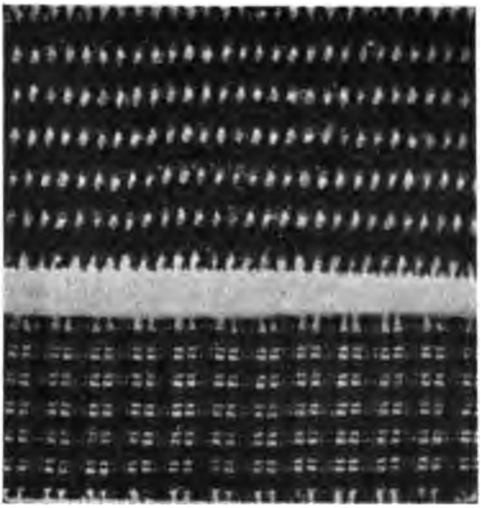

Fig. 247.

In the pattern shown in the upper portion of Fig. 247 two ends are placed regularly in each split of the reed, but in the lower pattern the order of denting is arranged 8 ends in 4 splits, 2 splits missed, 2 ends in 1 split, and 2 splits missed. The ends are thus separated as shown in the corresponding flat view given at D in Fig. 248, for which E is the draft, and F the lifting plan. Plain weave is formed for five picks by the doup and back crossing heald lifting alternately with the standard heald, then the doup and front crossing heald are lifted, forming a crossed shed for one pick which is clearly separated from the five plain picks. An open effect is thus formed horizontally which corresponds with that formed vertically by the missed dents, and a check pattern results. The number of ends and picks in each group may be varied as desired, but if the crossing is required to be clear and precise, each group of plain picks should consist of an odd number, and the standard ends should be down on the picks which precede and succeed the crossing. The styles shown in Fig. 247 may be effectively ornamented by using different colours or thicknesses of warp and weft yarn, and they may also be readily combined in stripe form with other weaves.

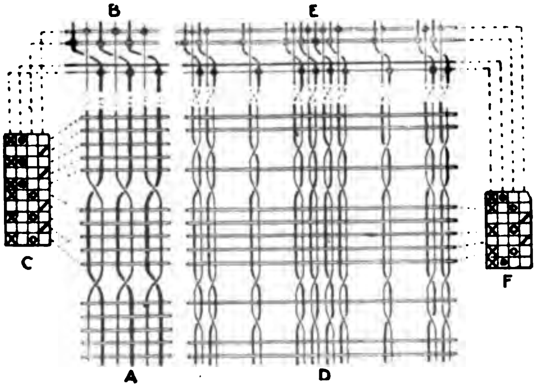

Fig. 248.

A flat view of a gauze and plain weave combination is given at G in Fig. 249, which may either be used by itself or be arranged in stripe form with another weave. In this case there are two crossing ends and three standard ends in each group, the former being drawn alternately on two back crossing healds, and drafted alternately to left and to right of the standard ends, which are also drawn on two healds, as shown at H. The lifting plan is given at I, and it will be seen that the standard ends work in perfectly plain order throughout, but the crossing ends only work plain when they are operated on the open shed side of the standard ends. When the crossed shed is formed the two crossing ends in each group work alike, since there is only one doup. As there is always either the front or one of the back crossing healds raised the doup requires to be lifted on every pick; but on account of the standard healds working plain a shaker motion is unnecessary for them in open shedding. The style may be modified in various ways; and excellent results are obtained, as the alternate grouping and spreading of the threads enables a comparatively compact texture to be combined with considerable openness. The example is illustrative of the necessity of care being taken in deciding upon which lifts to select as the crossed sheds. Thus, if the two picks which go together had been taken as the open sheds, the plain interweaving of the crossing ends would have been formed on the crossed sheds; hence two front crossing healds and doups and one back crossing heald would have been necessary, with the ends drafted in the opposite direction.

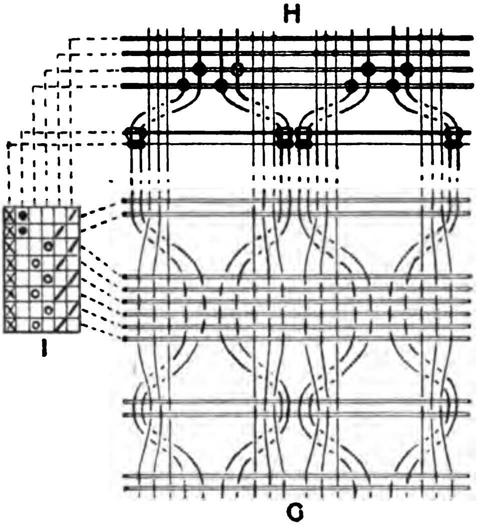

Fig. 249.

SIMPLE "NET" LENOS

The term "net" or "spider" leno is commonly applied to doup styles in which the crossing ends are mostly floated on the surface of the cloth, and are interlaced so as to form waved lines. The effect formed by the crossing ends is usually a chief feature of the pattern, and these ends, therefore, require to be of special material, colour, or thickness, so that they will show in clear contrast with the ground. Each group of standard ends generally forms a somewhat compact ground structure across which the doup ends are traversed, the latter ends being really introduced on the extra warp principle. An agreeable open appearance is, however, frequently given to a fabric by suitably missing splits between the groups of ends (see Fig. 273).

Fig. 250 illustrates a style in which the crossing ends are all drafted in the same direction across four standard ends. A portion of the structure, showing how the threads interlace, is represented at A in Fig. 251, while the draft is given at B, and the lifting plan at C. The standard ends, as is very frequently the case in these styles, work two ends together in plain order throughout, in order that they will spread out as much as possible; and they are also kept as straight as possible in the cloth, so that the maximum amount of traverse will be given to the crossing ends. Fig. 251 illustrates the production of the effect wrong side up with a bottom doup, the crossing ends being lifted on one pick in every five. The order of lifting fits with the plain interweaving of the standard ends: thus, where a crossing end is raised, the double standard end next to it is left down, and the former is held by the weft against the latter. Fig. 250 illustrates a good method of colouring the ground of a net leno style. Thus, light crossing ends are introduced on a dark ground and dark crossing ends on a light ground, while to correspond with the vertical lines formed by the crossing ends narrow horizontal lines are formed by light picks on a dark ground, and by dark picks on a light ground.

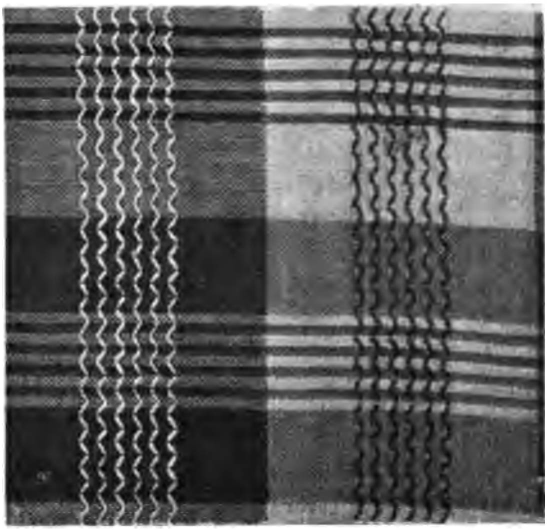

Fig. 250.

The fabric represented in Fig. 252 shows a modification of the last style produced by pointed drafting, a method which can be used very effectively for giving prominence and variety to the zig-zag interlacing. A flat view, showing the interweaving of the threads in the broad leno stripe, is given at D in Fig. 253, the draft at E, and the lifting plan at F, in this case the production of the effect being represented right side up with a top doup. Each doup end is drawn to right or to left over three double standard ends. The crossing ends are lifted for 4 picks, on which they lie across the standard ends, and depressed for 2 picks, on which they are held by the weft either on one side or the other of the standard ends. The marks in F represent where the healds are lifted and the easer operated, and it will be noted that the latter takes place when the front crossing heald is depressed.

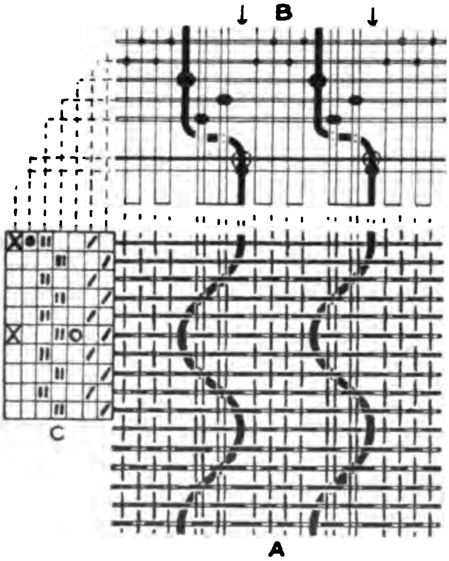

Fig. 251.

Comparison of Top and Bottom Doup Pegging Plans.—The construction of the lifting plan for a top doup draft is more difficult than in the case of a bottom doup, as the healds are mostly at the top and are depressed to produce the crossed interweaving. It is a good plan to first indicate lightly—say, in circles—where the doup and the front and the back crossing healds are to be depressed; then to fill in the spaces for these healds with marks except where the circles are indicated, the latter marks being afterwards rubbed out. A comparison of G in Fig. 253 with the three spaces in F. with which G is linked, will serve to make the method clear. The lifting plan of the healds for a top doup is just opposite to that for a bottom doup if the doup is in front of the front crossing heald in both cases, but the easer is operated at the same time in both.

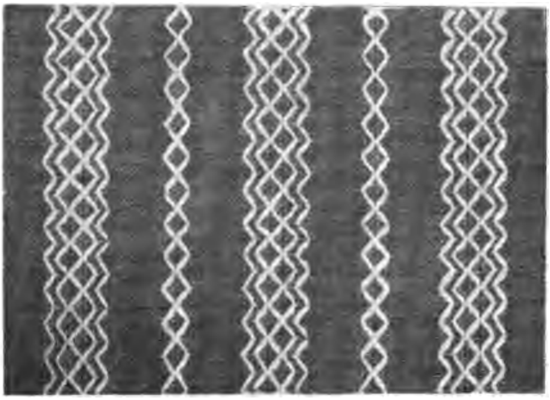

Fig. 252.

Denting Net Lenos.—As each group of crossing and standard ends must be placed together in one split of the reed, the denting of these styles is a very important feature. For example, in the fabric represented in Fig. 252, there are 22 ends in each plain stripe which are reeded 2 per split, while in the narrow doup stripe there are 2 groups of ends which must be placed in two splits, and in the broad doup stripe 5 groups, which must be placed in 5 splits. The narrow doup stripe, however, occupies the width of 12 ends, or 6 splits of the plain stripe, and the broad doup stripe the width of 26 ends or 13 splits. Sometimes the required spacing of the ends is obtained by plucking out the wires of the reed at the proper places, but this has the disadvantage that the reed can then only be used for a similar form of stripe. As a general rule, the effect can be produced by suitably missing splits between the groups of ends, the double standard ends, in working plain, readily spreading out and filling up the spaces.

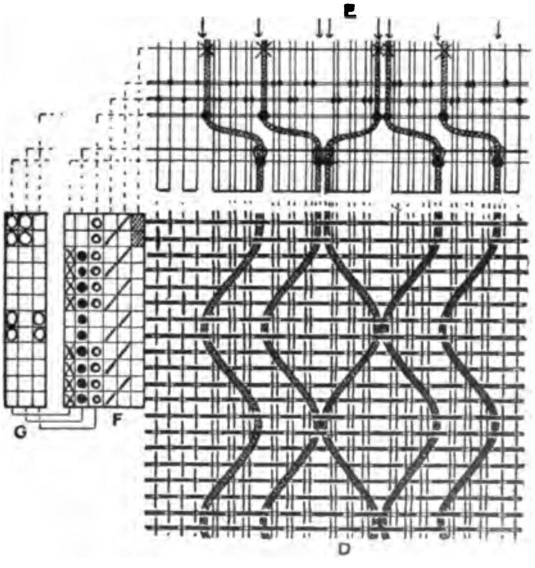

Fig. 253.

If the reed is fine and there is a considerable number of ends to a split, there may be too much friction upon the warp, but this can be reduced by tying the wires of the empty splits together with twine near the balks, and thus widening the spaces between the wires where the ends are passed. The denting of the stripe given in Fig. 252 is indicated by the horizontal lines below the draft E in Fig. 253, while the arrows shown above represent where the eight splits require to be missed to make up the width of 13 splits in the leno stripe.

Designing Net Lenos and Features to Note.—Even with only one front and one back crossing heald, great variety of effect can be produced by suitably varying the arrangement of the ends, the draft, and the lifting plan. In designing a number of styles, point-paper may be very conveniently used, and two effects are thus indicated at H and K in Fig. 254. The standard ends are first marked in (as shown by the double vertical strokes, which may be taken to represent two ends per mail), a blank vertical space being left on both sides of each group; then the interlacing of the crossing ends is schemed, and marks are inserted on the blank spaces to show where the front and back crossing healds are operated. In H and K, Fig. 254, the full squares and crosses respectively show where the front crossing and the back crossing healds are operated, and thus indicate warp in bottom douping and weft in top douping, the other marks representing warp or weft up as the case may be. The draft and lifting plan may readily be constructed from such plans for either method of douping. (In H the full squares and crosses represent weft, and the plain marks warp.)

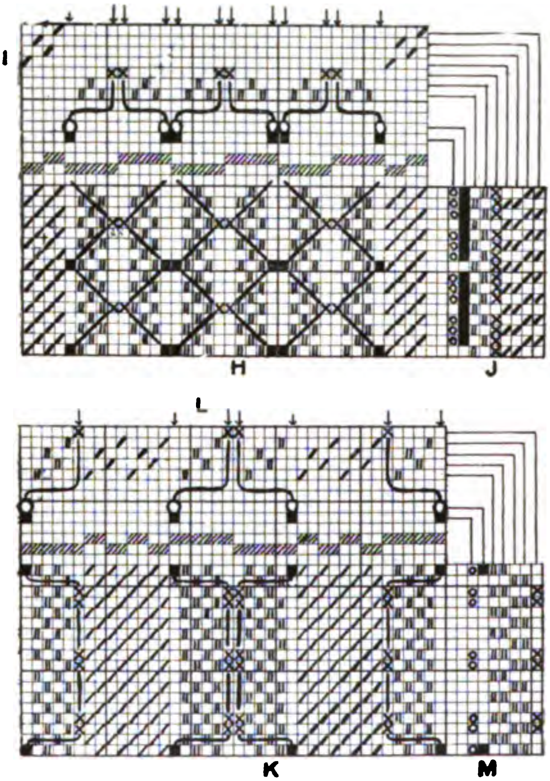

Fig. 254.

H in Fig. 254 corresponds with the net leno stripe shown in the extra warp stripe fabric that is represented in Fig. 155 (p. 138). The crossing ends traverse three double standard ends which work plain, the draft being given at I, and the lifting plan at J for top douping. The binding in of the crossing ends is effected on one pick only at a place, which necessitates, in order to get a clear cross at each traverse, (1) that the interweaving of the crossing ends must cut with the plain interweaving of the standard ends; (2) that the standard ends must be point-drafted in the same manner as the doup ends. In reference to the first feature, comparison with A in Fig. 251 will show that when the standard ends work plain and the crossing ends are bound in by one pick only, the binding picks must be separated by an even number of picks when there is an even number of standard ends, and by an odd number of picks when there is an odd number of standard ends. In reference to the second point, in a pointed doup draft, and with the binding effected on one pick only at a place, the outer ends of contiguous groups of standard ends must work alike. This, however, is not necessary when the crossing ends are bound in each time on two consecutive picks, in the manner shown at D, in Fig. 253, and K, in Fig. 254. A comparison of these examples with A, in Fig. 251, and H, in Fig. 254, will show that binding the doup ends on two successive picks has the advantages that a more perfect plain foundation can be formed by the standard ends, and that either an odd or an even number of picks may separate the binding picks; while in addition, when fine, tender weft is used, there is less liability of the crossing ends breaking the yarn and being irregularly stitched in.

K, L, and M, in Fig. 254, correspond with the fabric represented in Fig. 255, in which each doup end crosses four double standard ends. The plans show the production of the effect wrong side up with a bottom doup, therefore the full squares and crosses in K and M indicate where the doup ends are raised for binding. The crossing ends are mostly on one side of the standard ends, being on one side for 14 picks, compared with 2 picks on the other side; and the example illustrates an important point to note when this is the case, viz., to draft in such a manner that as few crossed sheds as possible will be formed. By drawing the crossing ends in the direction shown at L, the crossed shed is formed only on 2 picks in the repeat, while the open shed is formed on 6 picks; whereas if the doup ends had been drafted in the opposite direction, three times as many crossed as open sheds would have been made. In Fig. 254, the grouping of the ends in the reed is indicated by the shaded squares below the drafts, while the arrows above show where splits are missed.

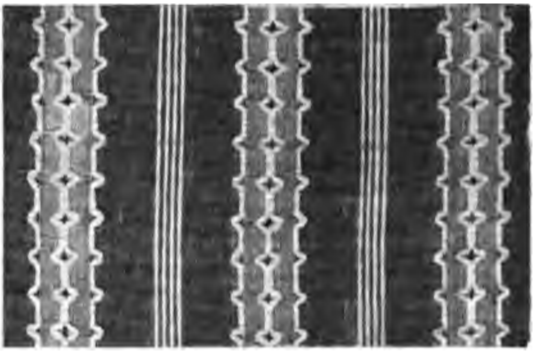
Fig. 255.

Production of Pattern by Varying the Lifts of the Standard Ends.—Fig. 256 illustrates a method of producing variety of pattern in net leno styles by varying the lifts of the standard ends. N shows a somewhat exaggerated view of an effect combined with a 4-thread warp sateen stripe; O is the draft in which each doup end is drawn across four standard ends, and P the lifting plan. The arrangement is for a bottom doup, hence the full squares and crosses in N and P indicate the lifts of the front and back crossing healds respectively. The other marks also represent warp up, but the waved lines will be formed by the doup ends on the underside of the cloth during weaving. The crossing ends are sometimes traversed across the four standard ends under which they are drafted, but at other times only across two ends; and in the plan N a space is left in the centre of each group of standard ends in order that the intermediate position may be more conveniently shown. When in the latter position, two of the standard ends are lifted, and two are left down, but as shown in P, the front crossing heald, or the back crossing heald—as the case may be—is lifted as usual. The lifting of the crossing ends will cause them to actually move across the four standard ends, but as at the same time the two standard ends nearest the position where the crossing ends are lifted are also raised, the latter slide along the weft picks until they are held by the weft against the two standard ends which are down. Further diversity of effect can be produced by modifying the order of lifting and the draft, still using four standard healds; while by employing a larger number of standard healds, much greater scope is given for pattern development with one front and one back crossing heald.

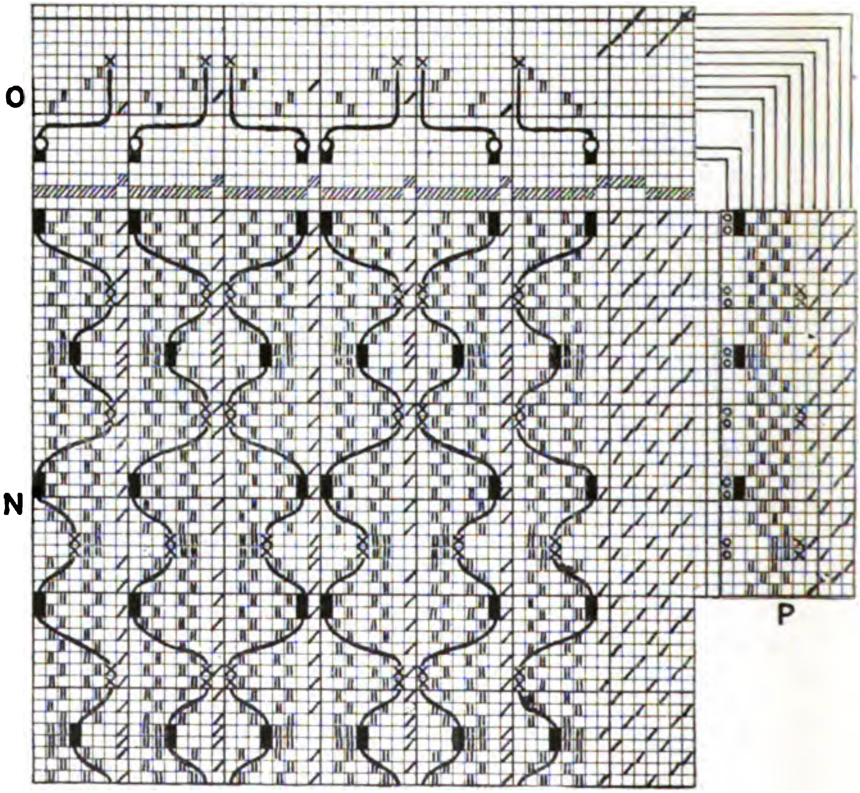

Fig. 256.

Bead Mounting for Net Lenos.—In this system, which may be readily employed for net leno styles such as have been illustrated, the doup is dispensed with, a number of beads being substituted, one for each loop of the slip; two ordinary healds are used for the front and back crossing healds, and two easers are required. The arrangement is represented in Fig. 257, which, in order that comparisons may be made, shows how the pattern given in Fig. 252 would be produced on the bead principle; while the illustrations D, E, and F, in Fig. 257, correspond with those similarly lettered in Fig. 253. A limitation of the bead system is that it is necessary for each waved line to be formed by two threads, which are interlaced in the cloth as one; but as it is usual in net lenos for a somewhat thick crossing thread to be used, in most cases this is not detrimental, a similar result being obtained by using two finer threads. In E, Fig. 257, the ends which form the plain stripe, and the double standard ends, which are in groups of three, are shown drawn on two healds, S 1 and S 2. A crossing end is drafted on each side of each group of standard ends, one being drawn through the heald B 1, and the other through B 2; then they are passed together through the eye of a bead, represented by a circle. The ends, carried by the heald B 1, are passed in contact with an easing bar E 1, and those carried by B 2 in contact with an easing bar E 2. The order of denting, indicated above the draft, is the same as in doup weaving, and the beads, which, of course, are behind the reed, slide to and fro on the crossing ends with the movement of the sley. D, in Fig. 257, shows a flat view of the effect on point-paper, the double waved line representing the traversing of the pairs of crossing ends; while the crosses indicate the positions where they are stitched in by the weft on one side of the standard ends, and the full squares the positions on the other side. In producing the structure right side up (to correspond with a top doup), the crossing ends are passed through the beads above the standard ends, but if woven wrong side up (to correspond with bottom douping) they are passed through the beads below the standard ends.

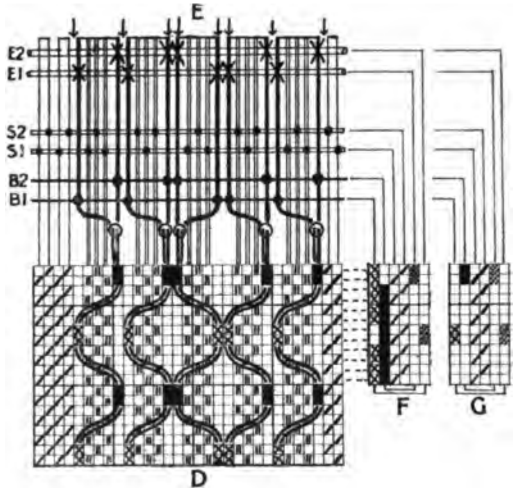

Fig. 257.

The plan F in Fig. 257 shows the order of lifting in producing the cloth right side up, the two standard healds, S 1 and S 2, working plain throughout. When both the healds B 1 and B 2 are raised the two easers are out of action, and the crossing ends lie on the surface of the cloth. When the heald B 1 is depressed, the easer E 2 is operated, and slackens the ends carried by the heald B 2, and the two ends of each pair are drawn down and stitched in on that side of the standard ends where the crosses are indicated in D. Similarly, at the same time that the heald B 2 is depressed, the easer S 1 is operated, and slackens the ends carried by B 1, thus allowing both ends of a pair to be stitched in on that side of the standard ends where the full squares are indicated in D. G, in Fig. 257, shows the order of lifting for producing the cloth wrong side up, the healds B 1 and B 2, in this case, being alternately raised to bind in the crossing ends, while as before the easing slackens the ends that are carried by the heald which is stationary. The chief advantage of the arrangement is its cheapness, the cost of the beads, which practically never wear out, being merely nominal in comparison with the expensive doup. At the same time the shedding of the healds is simpler than in doup weaving, and the parts easier of arrangement; but when more than one order of crossed interweaving is required the mounting becomes complicated on account of two easers being required for each series of beads.

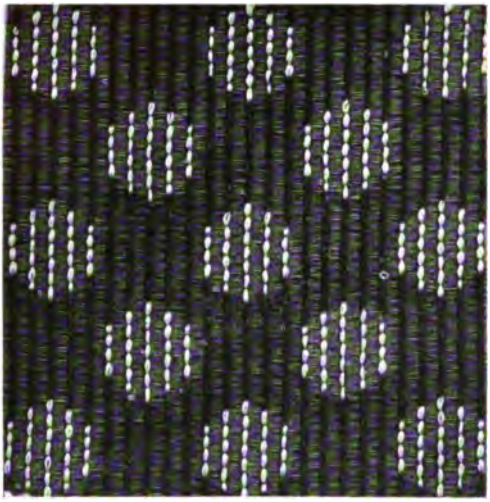

Fig. 258.

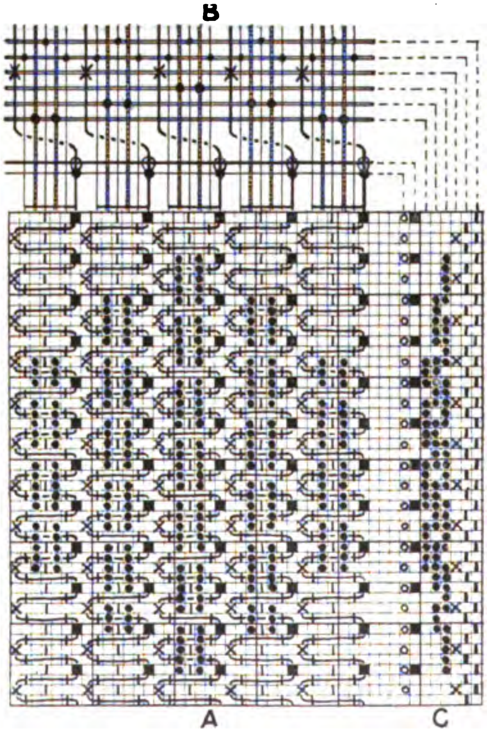

Fig. 259.

COMBINATIONS OF GAUZE AND LENO WITH EXTRA WARP AND EXTRA WEFT EFFECTS

Fig. 258 illustrates a simple but useful principle of ornamenting an open leno and plain structure by means of extra warp. There are six ends in each group, which are arranged as follows: — One standard, one extra, one standard, one extra, and one standard, under which a crossing end is drawn from left to right, as shown in the draft given at B in Fig. 259. A representation of the working of the threads which form one spot is given on point-paper at A in Fig. 259, in which, for convenience in showing the crossed interlacing, a space is allotted for each crossing end at each side of the standard and extra ends, 7 vertical spaces being thus allowed for 6 ends. C shows the lifting plan of the portion of the design given with the draft B, but it will be understood that in producing the full design three additional healds are required to form the second extra warp spot. The standard ends work in plain order throughout, as shown by the vertical strokes in A and C; the crossing ends are raised on the second of each group of four picks by the back crossing heald, as shown by the crosses, and on the fourth of each group by the front crossing heald, as shown by the full squares, while the extra ends are raised only where the figure is required to be formed, as indicated by the dots. The half-heald is lifted on all the even picks, as shown by the circles in C. There are 8 groups of ends per inch, and the style would be conveniently produced in a reed with 24 splits per inch, reeded 6 ends per split, and 2 splits missed alternately. For 100 yards of cloth, 105 yards of extra warp, 110 yards of standard warp, and about 190 yards of crossing warp are required, three beams thus being necessary. Large figures, which show in clear contrast with the ground, may be woven on this principle by means of a small number of healds, while another feature of the style is that the traversing of the crossing ends binds in the extra ends on the back. There is, therefore, no difficulty in disposing of the extra ends where they are not required to form figure, and at the same time, as they are below the standard ends they are quite invisible from the face side of the cloth.

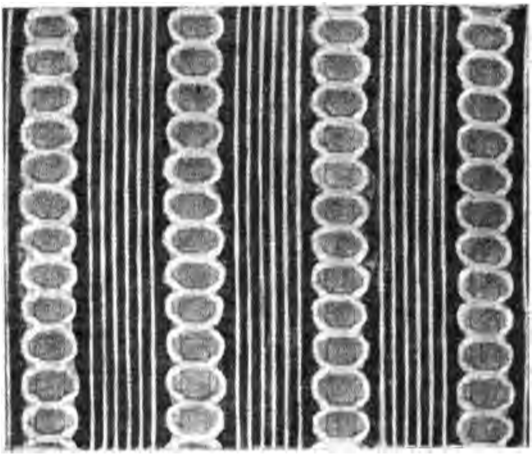

Fig. 260.

Fig. 260 shows a combination of net leno with an extra warp spotted stripe, the plan for which is given at D in Fig. 261, while the draft and lifting plan for top douping are respectively indicated at E and F. The crossed shed is formed on four successive picks, on which all the standard ends are raised, therefore separate healds, from the plain ground healds, are required for the standard ends. Only one heald is required for the extra warp spot, which on paper appears rectangular, but on the crossed sheds the picks, which bind the crossing ends, float right across from one to the other. The spot thus has a rounded appearance in the cloth, with a white outline formed by the doup ends and the weft. As shown in the denting plan, below the draft, the ground ends are sleyed two per split, and there are, therefore, four ends per split where the extra warp spot is formed, while a split is missed on each side of each group of standard ends, as indicated by the arrows above the draft.

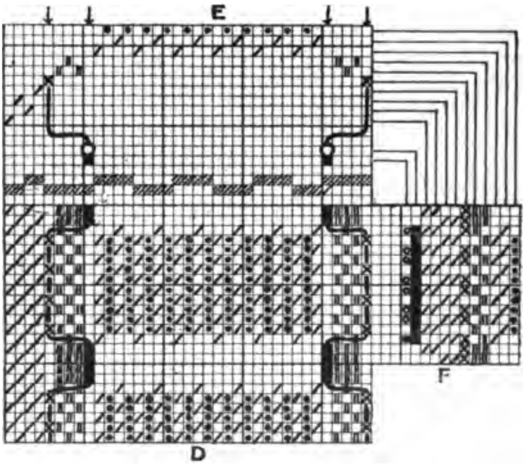

Fig. 261.

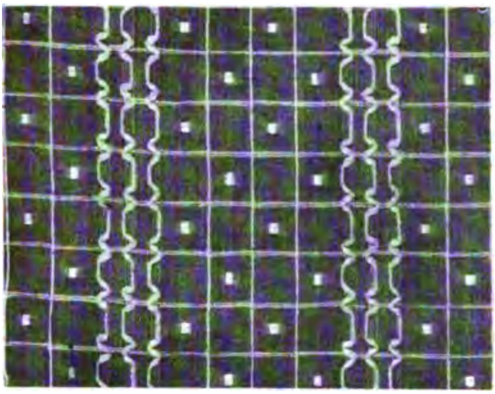

Fig. 262.

Fig. 262 shows the combination of net leno with an extra weft spot formed in the centre of an over-check. A plan of a portion of the effect is given at A in Fig. 263, and the corresponding draft and lifting plan for a bottom doup at B and C respectively; the weave marks representing warp up, while the waved lines show how the crossing ends interlace. The shaded marks in A represent the positions of the white check lines in the cloth, while the brackets at the bottom of the plan denote the ends that

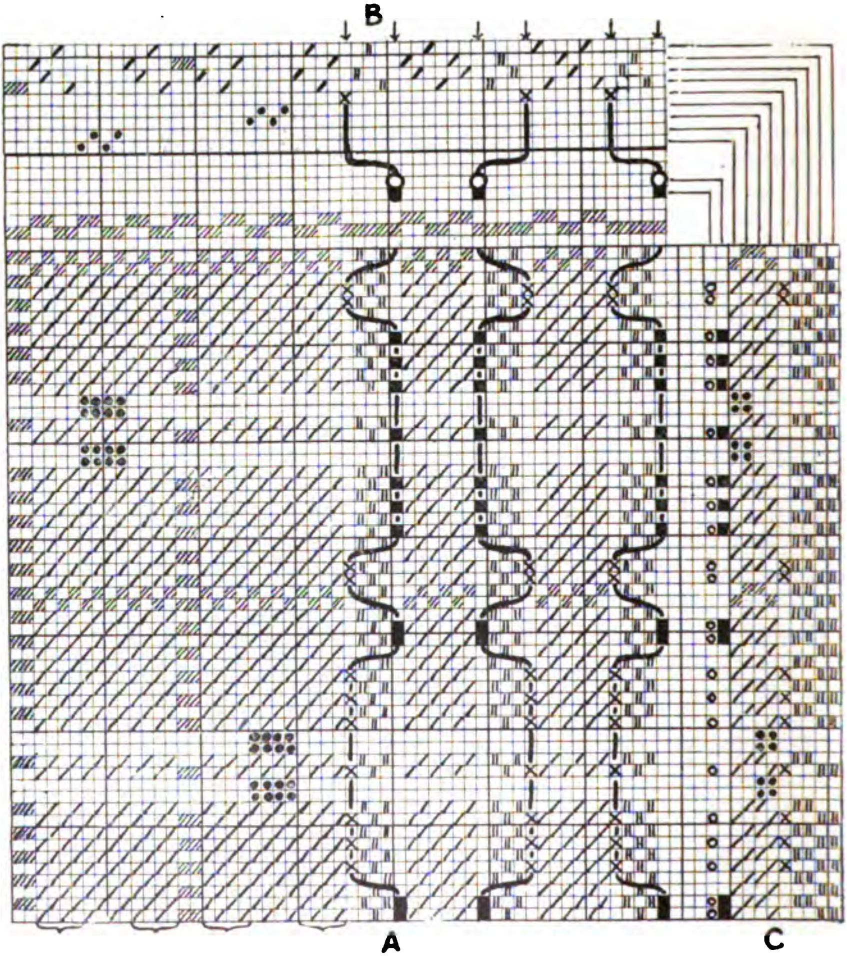

Fig. 263.

are repeated in forming the complete check. The dots indicate the ends that are raised in producing the extra weft spot on the underside, the extra picks being introduced in even numbers with the ground picks. The interweaving of the doup ends is the same on one side as on the other side of the standard ends —exactly the same number of crossed as open sheds being made—therefore in this case the ends may be drawn with equal advantage in either direction across the standard ends. The crossed interweaving fits with the repeat of the overcheck and the extra weft spot, hence it is necessary for the boxing and take-up motions to be kept perfectly in unison with the shedding. The example may, therefore, be most advantageously produced by using the shedding motion to govern the box mechanism, and for throwing the take-up catch out of action when the extra picks are inserted.

The different positions of the back crossing heald in relation to the standard healds may be noted by comparing the drafts given in Fig. 254 (p. 236) with that shown in Fig. 263. In Fig. 254, the back crossing heald is placed behind the standard healds, an arrangement which is frequently adopted in order to reduce the acuteness of the angle that is formed when the crossed shed is made. Any advantage that is thus gained in reduced strain, however, is liable to be neutralised by the friction caused by the crossing ends rubbing against the leashes of the standard shafts; this being particularly the case when the standard healds are finely set. In Fig. 263, the back crossing heald is in a better position, as in this case it is placed in front of the standard healds, while the strain on the crossing ends is reduced by placing it behind four ordinary healds.

TWO OR MORE DOUP PATTERNS

Two or more doups and front crossing healds, with a corresponding number of easers, are sometimes required for net leno effects, for certain styles of open structures, and for patterns in which net leno and open effects are combined. Fig. 264 shows a 2-doup net leno arranged in stripe form with an extra warp effect, the corresponding sectional plan, draft, and lifting plan for which are given at A, B, and C, respectively, in Fig. 265. The arrangement is for top douping, hence the full squares and crosses in A represent doup ends down, while all the other marks represent warp on the surface. The doup ends cross from side to side of three double standard ends, half the crossing ends working exactly like the other half except that they are turned in opposite directions by means of pointed drafting; and each gauze stripe in Fig. 264 contains two repeats of the crossed interlacing shown in A. The interlacing of the outer crossing ends repeats on 8 picks, and of the inner crossing ends on 16 picks, but the complete design occupies 48 picks (of which only 24 are shown) on account of the extra warp weave (represented by dots) repeating on 6 picks. The fact that two crossing ends are traversed in a different manner from each other does not necessarily mean that two doups are essential, but in this case it will be apparent from an examination of the marks in A, which show the binding in of the first two crossing ends, that two doups must be used. Thus, neither the crosses nor the full squares of the first crossing end correspond in arrangement with either the crosses or the full squares of the second crossing end, and it is, therefore, clear that two back crossing healds, as well as two front crossing healds and doups, are required. If, however, the crossing end lifts, either on one side or the other of the first group of standard ends, had been the same as those on either side of the second group, it would have been possible to produce the effect with one front crossing heald and doup, although two back crossing healds would have been necessary (see Fig. 272). The denting of the pattern is shown below the draft in Fig. 265, while the arrows indicate where splits are missed.

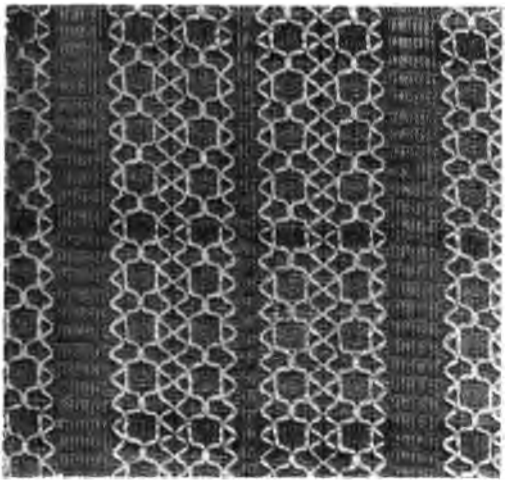
Fig. 264.

Fig. 266 shows an open structure in which, by means of two doups, the picks are distorted by being grouped together and then separated in alternate sections, the cloth being given a spider's web appearance. A flat view of the structure is given at D in Fig. 267, and the draft and lifting plan for bottom douping at E and F. The crossing ends, represented by solid lines in D, are always raised, therefore the half-healds are lifted on every pick, as shown by the circles in F; while the standard ends are always down, only one standard heald being required. Each back crossing heald lifts its crossing ends on nine successive picks, which, being in the same shed, are readily inserted towards each other; then a crossed, an open, and a crossed shed are successively formed, causing three picks to be clearly separated from each other and from the group of nine picks. The grouping and separating of the picks by the two sets of healds, however, occur at different periods, with the result that the three upper and three lower picks pass from one group of nine to another.

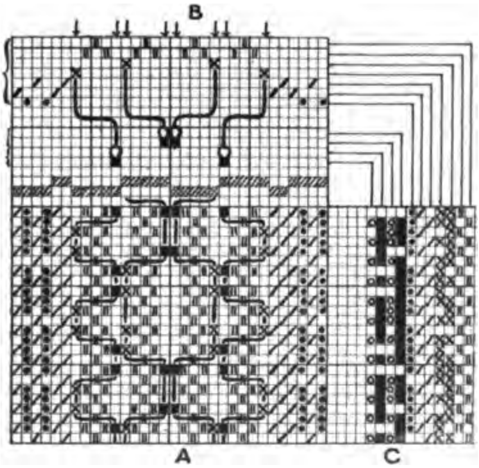

Fig. 265.

Fig. 268 shows a 3-doup style in which a net leno stripe, requiring one doup, is combined with an open structure, the latter consisting of alternate sections of gauze and plain for which two doups are required. A flat view of a portion of the effect, and the corresponding draft and lifting plan are given at G, H, and I, respectively, in Fig. 269. The order in which the ends are grouped in the reed is indicated above the draft, and two splits are left empty in the centre of the net leno stripe. The arrangement shows the combination of top and bottom douping, the whip crossing ends being drawn in pairs *over* three double standard ends which work plain throughout; while in the gauze and plain section two crossing ends are drawn *under* two standard ends. In the open gauze structure the ends and picks are grouped in fours, the crossing ends being over, and the standard ends under the picks. This order of shedding is also employed on the picks which precede and succeed the open interlacing, the change from the plain weave to the crossed shedding and *vice versa* being thus made gradually. The net leno stripe requires one back crossing heald and two standards, but on account of formation of the plain weave two back crossing healds and two standards are required to correspond with each of the other doups. With the exception of the whip ends, all the ends take up equally, hence the effect may be produced by the use of two warp beams, but three easers are required to correspond with the three doups.

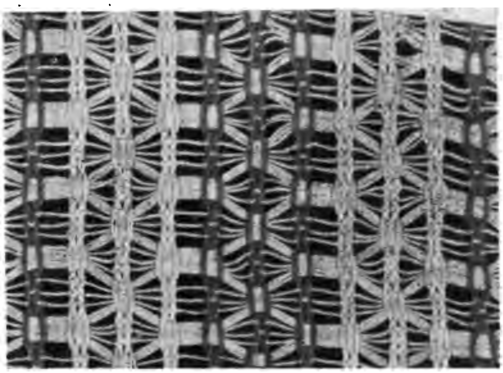

Fig. 266.

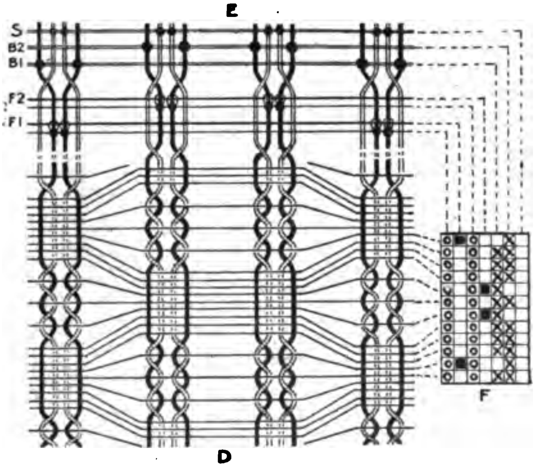

Fig. 267.

Fig. 270 shows a 3-doup check effect in which there are two special features—viz., the crossing of thick ends carried by one doup, across fine ends controlled by another doup; and the deflection of thick picks horizontally to correspond with the vertical waved lines formed by the thick ends. A flat view of the structure is given at J in Fig. 271, and the corresponding draft and lifting plan at K and L respectively. The three groups of threads are correspondingly numbered in the illustrations, and exactly one repeat of the lifting plan is indicated by the bracket at the side of L. In reference to the first feature the pairs of fine ends numbered 2 act as standards to the thick doup ends numbered 1, and it is, therefore, necessary

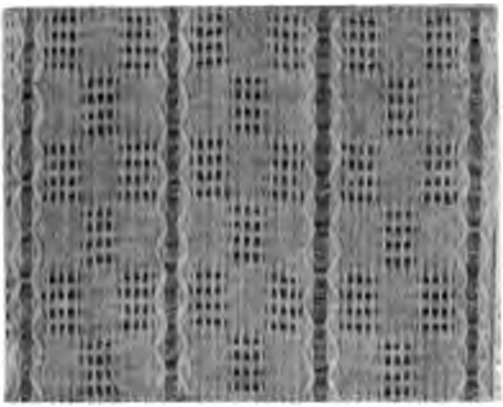

Fig. 268.

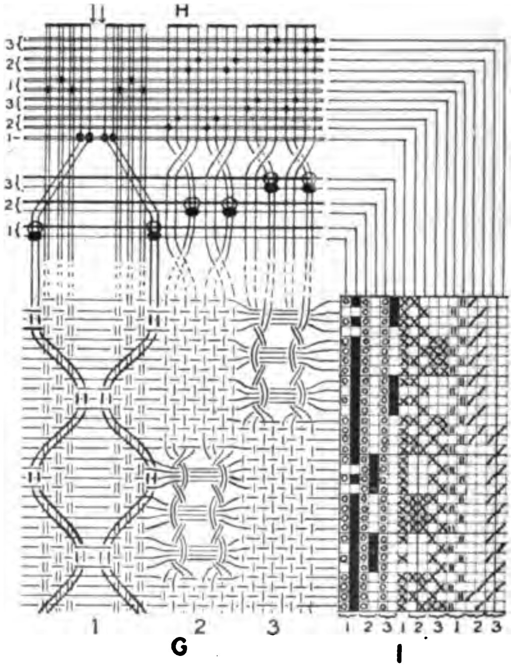

Fig. 269.

for the latter, in passing from the back crossing heald 1 to the front crossing heald 1, to cross under the former in front of the doup 2. In regard to the second point.

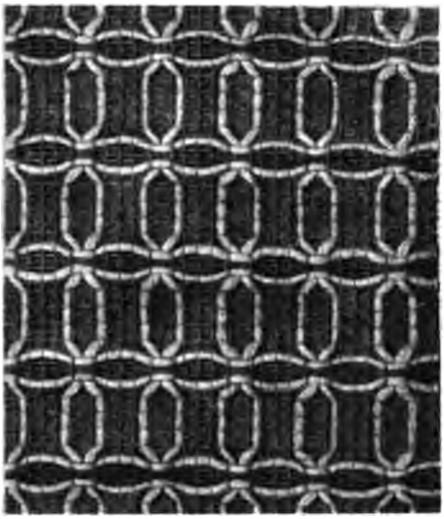

Fig. 270.

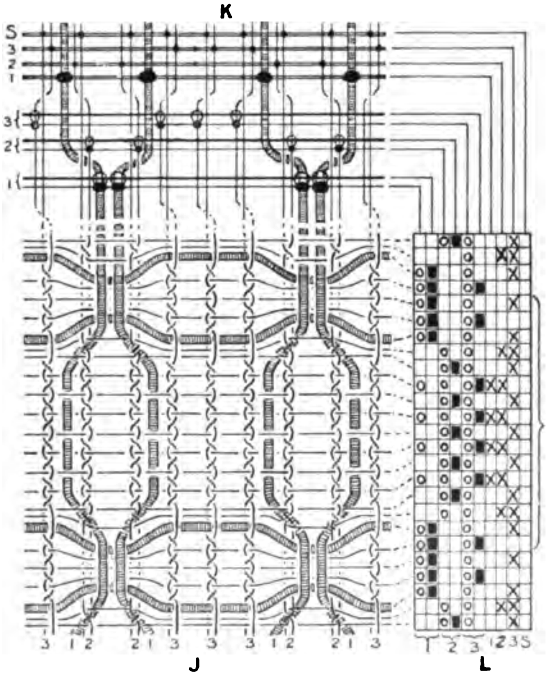

Fig. 271.

the fine ends 2 form the crossed interlacing on all the eleven fine picks between the thick picks, then a crossed shed is formed by the doup 1 on the two thick picks and the three fine picks between them, during which the fine ends 2 float at the back. The five picks, being in the same shed, are readily compressed by the crossed interlacing of the ends 2, and the thick picks thus approach each other where they intersect the ends 2. The fine ends 3 form the crossed interlacing on the three picks between the thick picks, and as the latter are in the same shed as the two ground picks on the opposite sides, they are readily forced apart where they intersect the fine ends 3. The cloth is woven right side up by means of bottom douping.

PATTERNS PRODUCED BY ONE DOUP AND TWO OR MORE BACK CROSSING HEALDS

In this principle the idea is to produce effects in which some of the crossing ends interlace quite differently from other crossing ends with a simple mounting, only one doup and front crossing heald, and one easer being employed. It is, of course, always advisable to use as few doups as practicable, and frequently it is possible to weave effects in a 1-doup mounting which have the appearance of requiring a large number of doups. As many back crossing healds are required, however, as there are different orders of interlacing employed for the crossing ends. The feature of the system is that since only one front crossing heald is employed, whenever this is operated, all the doup ends cross simultaneously to the crossed side of the standard ends; and so long as a back crossing heald is left out of action the crossing ends carried by it weave continuously on the crossed side of the standard ends. When, however, a back crossing heald is operated, the ends that it carries pass to the open shed side of the standard ends; therefore, by employing a number of back crossing healds, and operating them differently, varied orders of interlacing are formed. In the more elaborate styles the normal positon of the crossing ends in the cloth is on the crossed side of the standard ends, the traversing of the ends being really effected by the formation of open sheds when the back crossing healds are operated. The half-heald has to be operated, not only on the crossed sheds, but also whenever any one of the back crossing healds is brought into action. In drafting a given pattern, great care is necessary in deciding which is the crossed and which the open shed side of the standard ends, as according to the direction in which the crossing ends are drawn across the standard ends, an effect may require, for example, four doups and four easers, with one back crossing heald, or one doup and one easer with four back crossing healds.

Comparison with Two-doup Style.—A, in Fig. 272, shows a net leno structure in which there are two orders of interlacing the crossing ends, which, as shown in the draft B and the lifting plan C, can be produced by means of one doup and front crossing heald, and two back crossing healds. In order that comparisons may be made, the crossed interlacing in Fig. 272 is arranged similar to that represented in the 2-doup effect shown in Figs 264 and 265; and the example illustrates how a slight modification of the 2-doup effect would enable it to be produced by one doup. The extra warp, the ground ends, and the outer crossing ends work exactly the same in the two examples, but the centre crossing ends are drafted in the opposite direction in Fig. 272, and a slight change is made in the order of lifting. The repeat of the crossed interlacing is on 16 picks in both cases, but in

A, Fig. 272, it will be noted that the full squares, which indicate where the front crossing heald is operated, are always on the same picks, viz., 2, 8, 10, and 16. The crossing ends are, therefore, always on the crossed side of the standard ends on these picks, and they are traversed to the opposite side only when the back crossing healds are operated alternately with the front crossing heald. It will be seen that while the first back crossing heald is operated and traverses its threads on the picks 4 and 6, and 12 and 14, the second is only brought into action to traverse its threads on the picks 4 and 6, so that the latter threads lie straight on the surface of the cloth between the picks 10 and 16.

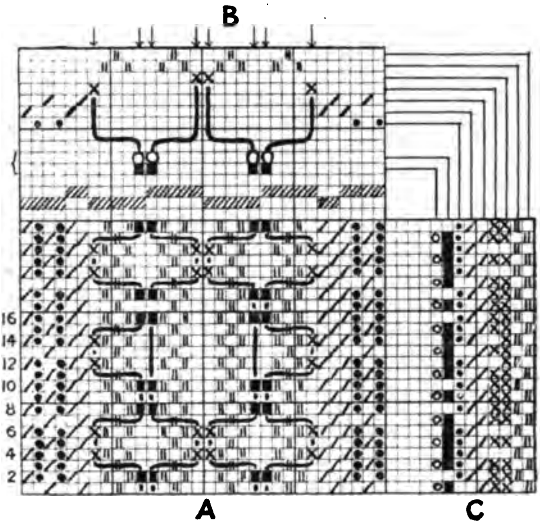

Fig. 272.

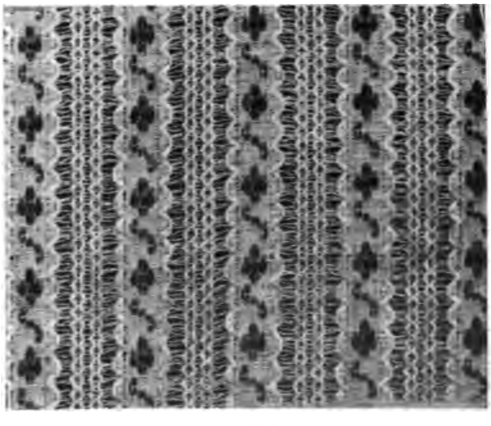

Fig. 273.

Fig. 273 shows an extra warp figure in two colours combined with a 1-doup net leno effect in which there are two different orders of interlacing. A point-paper plan of the pattern is given at D in Fig. 274, the draft at E, and the lifting plan for top-douping at F. The crossing end at each side of the extra warp stripe traverses two double standard ends, but in the centre of the doup stripe the traverse of each crossing end is only across one double standard end. The front crossing heald is operated on every fourth pick, and the back crossing heald for the centre crossing ends is operated alternately with it, but that for the crossing ends at the sides is only brought into action once in every eight picks. The crossing ends in the centre thus make twice as many traverses as those at the side, but as the latter move a greater distance the take up of the crossing ends is the same; therefore they can all be brought from one beam. The net leno stripe is given a very open appearance by splits being missed between the groups of ends; and arrows are indicated above the draft E to indicate the missed dents. In the extra warp stripe the figure is produced on a plain ground, the dots representing the figure formed by one extra warp, and the shaded squares that formed by the second extra. The reed has 44 splits per inch, and the grouping of the ends is indicated by the horizontal lines above the draft, two ground ends being placed in each split in the extra warp stripe; thus there are four ends per split where there is only one extra, and five per split where both extras are introduced.

Construction of Heald Knitting Plans for Gauze Stripes.—When knitted healds are used for a complicated draft, such as that shown at E in Fig. 274, it is very important that the leashes are spaced correctly, so that the ends will pass from the heald eyes through the reed without unnecessary friction. G in Fig. 274 shows how a plan may be readily contructed from a given draft and order of denting which will enable the healds to be knitted with perfect accuracy. Ordinary design paper may be used, and the piece of paper should contain as many vertical spaces as there are splits in the repeat, and as many horizontal spaces as there are healds. Thus G is 30 spaces wide and 16 spaces deep as the pattern is on 30 splits, and there are 14 healds in addition to the doup and front crossing heald. The lines which

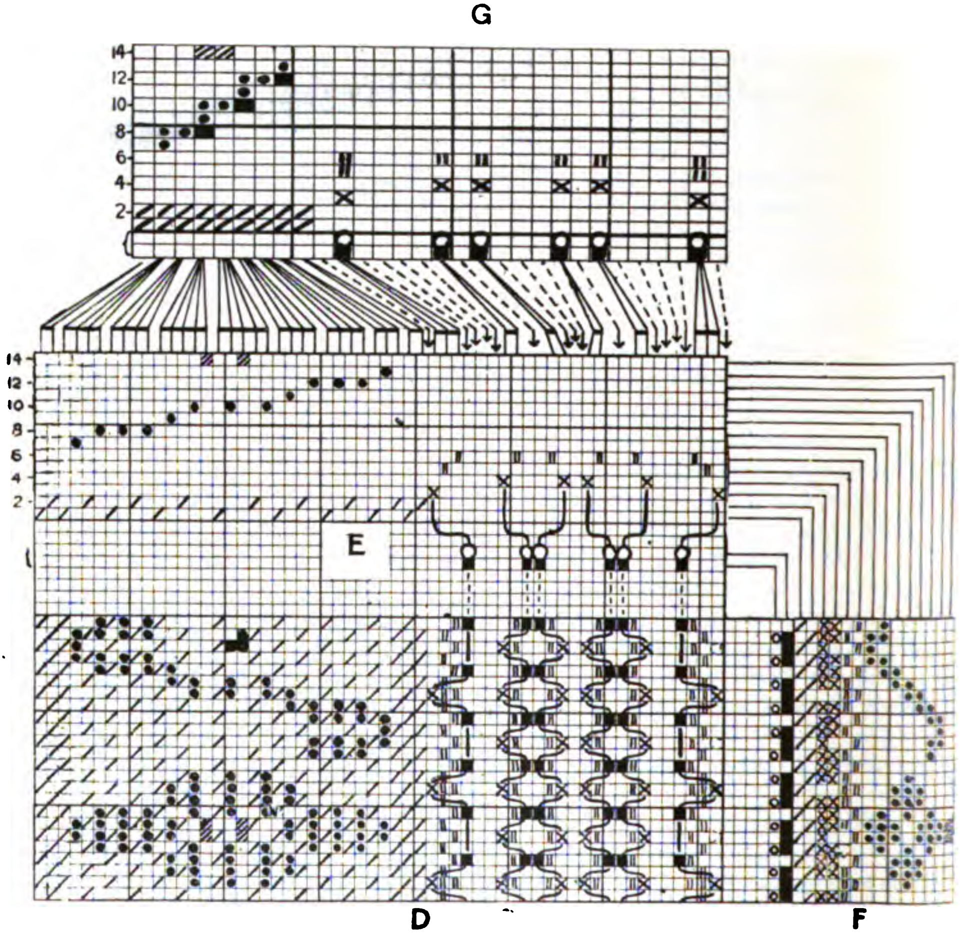

Fig. 274.

connect the draft and denting plan with G will enable the method to be followed. On each vertical space in G there are as many marks indicated as there are ends passed through the corresponding split, and on each horizontal space as many marks as there are ends drawn on the corresponding heald. The first split contains two ends which are drawn on the healds 1 and 2; therefore marks are placed in G where the first vertical space intersects the horizontal spaces 1 and 2. In the second split there are four ends which are drawn on the healds in the order of 1, 7, 2, 8, and marks are inserted in G where the second vertical space intersects the horizontal spaces 1, 7, 2, 8. This method is followed throughout except that where there are two ends on one heald in the same split, as on the heald 8 in the third split, one of the marks is placed on the square alongside its correct position, as shown where the solid squares are indicated in G. The dotted lines, which connect the arrows with the plan G, indicate where vertical spaces are left empty to correspond with the empty splits. The plan gives the exact position of the heald leashes in relation to the position of the ends in the reed, and if the rate of knitting is the same as the sett of the reed the order of knitting and missing will be obtained by reading along the spaces of G horizontally. It is, however, more economical for the healds to be knitted at a lower rate than the sett, and in the accompanying list the order of knitting and missing is shown in the centre column at the rate of the sett of the reed, and in the column on the right at half the rate :—

Position of Heald.	Rate of knitting = splits per inch of reed.	Rate of knitting = ½ splits per inch of reed.
Doup and front crossing heald, and heald 6	knit 1 1 1 1 1 1 miss 10 4 1 3 1 4 1	knit 1 2 2 1 miss 4 2 1 2
Healds 1 and 2	knit 9 miss 21	—
Healds 3 and 5	knit 1 1 miss 10 17 1	knit 1 1 miss 5 8
Heald 4	knit 1 1 1 1 miss 15 1 3 1 6	knit 2 2 miss 7 1 3
Healds 7, 9, 11, and 13	knit 1 miss 29	knit 1 miss 14
Healds 8, 10, and 12	knit 3 miss 27	knit 3 miss 12
Heald 14	knit 2 miss 28	knit 2 miss 13

It will be noted that in the second column the numbers knitted and missed total 30 to correspond with the 30 splits in the pattern, but in the third column the total is half that number, viz., 15, to correspond with the rate of knitting being reduced one-half. It is not advisable to knit the healds 1 and 2 at half the rate of the reed.

Fancy One-doup Net Leno.—Fig. 275 shows a typical example of a fancy net leno which has been produced in a one-doup mounting. The corresponding sketch plan is given at H in Fig. 276, in which, in order that the interlacing of the crossing ends will be more clearly seen, the plain weave of the standard ends is shown only on the first six picks. The draft is given at I and the lifting plan at J for bottom douping, five back crossing healds being employed. In H and J the full squares show the lifts of the front crossing heald, while the crosses show where the back crossing healds lift. Each doup end lies straight in the cloth—floating five and one—

on the crossed side of the standard ends except where the lift of a back crossing heald alternates with the lift of the front crossing heald; the figure being formed where the interlacing is straight, and the ground where the traverses are made. The doup is raised on every third pick, as shown by the circles in J. In designing styles of this character, the order of lifting the front crossing heald should first be decided upon, and corresponding marks be indicated upon the point-paper (as shown by the full squares in H) where the crossing ends will be bound in on the crossed sheds. Experimental sketches may then be made of different orders of traversing the crossing ends by forming open sheds, from which the drafts and lifting plans can be readily constructed. If possible, however, each crossing end should be given the same number of traverses, or the take up will vary and more than one crossing warp beam will be required. Thus, in Fig. 276, some of the doup ends make five, others six, and others seven, traverses in the repeat, and three whip beams were used in producing the effect.

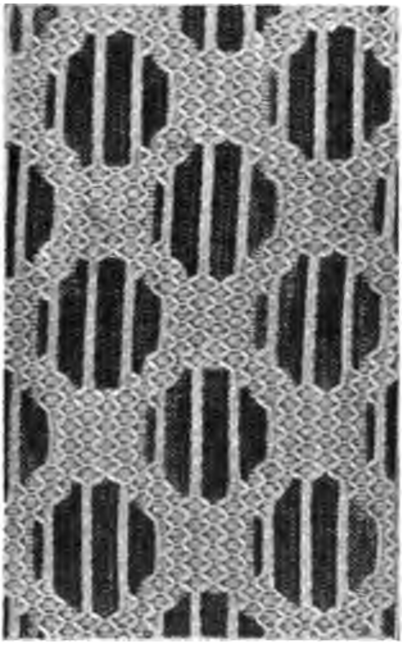

Fig. 275.

Distorted Weft Styles.—The pattern given in Fig. 277, and the corresponding illustrations A, B, and C in Fig. 278, show a method of distorting the picks in a 1-doup mounting, by which effects, similar to the 2-doup style given in Figs. 266 and 267, may be produced. One end crosses one end, and four back crossing healds—numbered 2, 4, 6, and 8, in the draft B—are employed. The front crossing heald always lifts on the even picks, and, as shown in the flat view A, each doup end lies on the crossed side of its standard end for seven picks which are grouped together, then a crossed interlacing is made which separates a pick from the group of seven picks. The lifts of the back crossing healds, which form the crossed interlacing, occur at different times, and some of the picks thus pass from one group to another. Where the seven picks are grouped together, the interlacing is arranged so as to permit the picks to approach each other as readily as possible, consistent with the lifting of the front crossing heald on alternate picks, on which the standard ends are down. On the other picks of each group the weft interlaces two-and-two, and the weave enables a considerable quantity of weft yarn to be put into the cloth, which renders it suitable for using as the ground of a figured gauze style in which the figured portion of the cloth is required to be compact. The structure may be varied in many ways, and D, in Fig. 278, shows a modification which can be produced by repeating the draft of the first eight ends shown in B, and using the lifting plan E. A more open distorted effect is produced than in A, which is suitable for a lighter wefted cloth, although this weave will allow many more picks to be inserted than can be obtained in a pure gauze, one crossing one.

Gauze and Figure Weave Combinations.—A further development in a single doup heald mounting is illustrated by the pattern in Fig. 279, a portion of which is represented at A in Fig. 280, while B shows the draft and C the lifting plan. There are two standard, one front crossing, and 12 back crossing healds, and one end crosses two ends. For convenience in showing the interlacing of the crossing ends a space is left in the plan A on each side of the standard ends. The standard healds work plain throughout, while the front crossing heald is always raised on the even picks; and it is the operation of these healds that produces the opaque figure portion of the cloth (represented by diagonal strokes in A), in which the crossing ends work continuously on the crossed side of the standard ends. The back crossing healds are only operated where the open-gauze structure is required, and in the plan A these places are represented where the crosses and full squares alternate on opposite sides of the standard ends, the former marks showing the

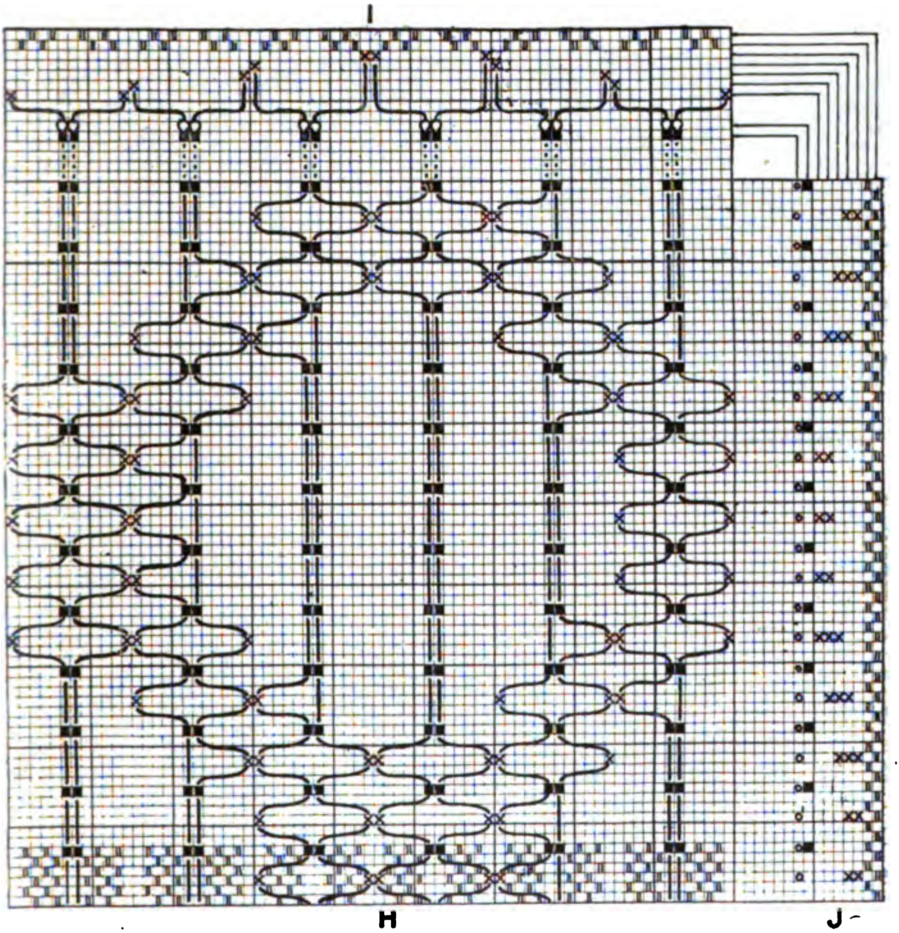

Fig. 276.

lifts of the back crossing healds. In the opaque figure the first and third ends of each group work alike, and if the warp and weft yarns are similar, a two-and-one weft rib effect is produced. The figure structure may, however, be developed as a warp rib by using thicker yarns for the crossing and the first standard ends than for the second standard end, and by wefting one pick fine, one pick coarse. As the standard ends work plain throughout a shaker is not required in a double-lift machine, and the style is, therefore, specially suitable for the production of elaborate effects in double-lift jacquards.

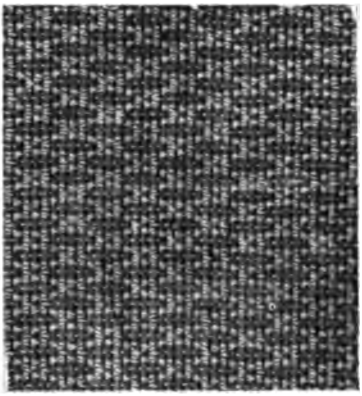

Fig. 277.

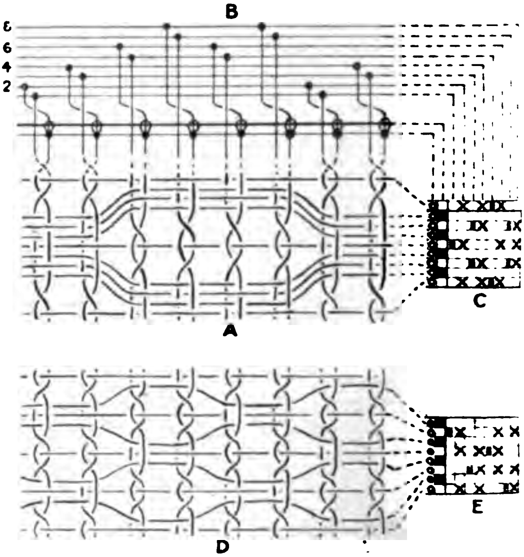

Fig. 278.

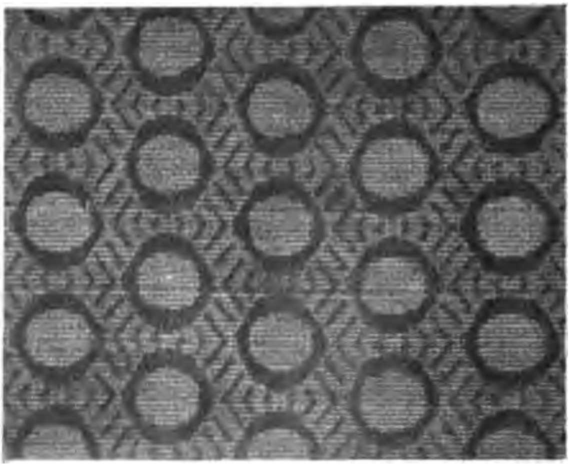

Fig. 279.

Fig. 281 shows a single-doup effect, which is a combination of gauze and plain weave, in which one crosses one. A simple example, to illustrate the production of the style, is given in Fig. 282, and for convenience in grouping the illustrations, a method of producing warp (or weft) float, in addition to the gauze and plain, is shown in the same figure. Two plans A and B are given at opposite corners of Fig. 282, the first showing a combination of plain weave and gauze—the latter effect being represented by the blanks—and the second a combination of plain, figure, and gauze. Flat views, to correspond with A and B, are given respectively

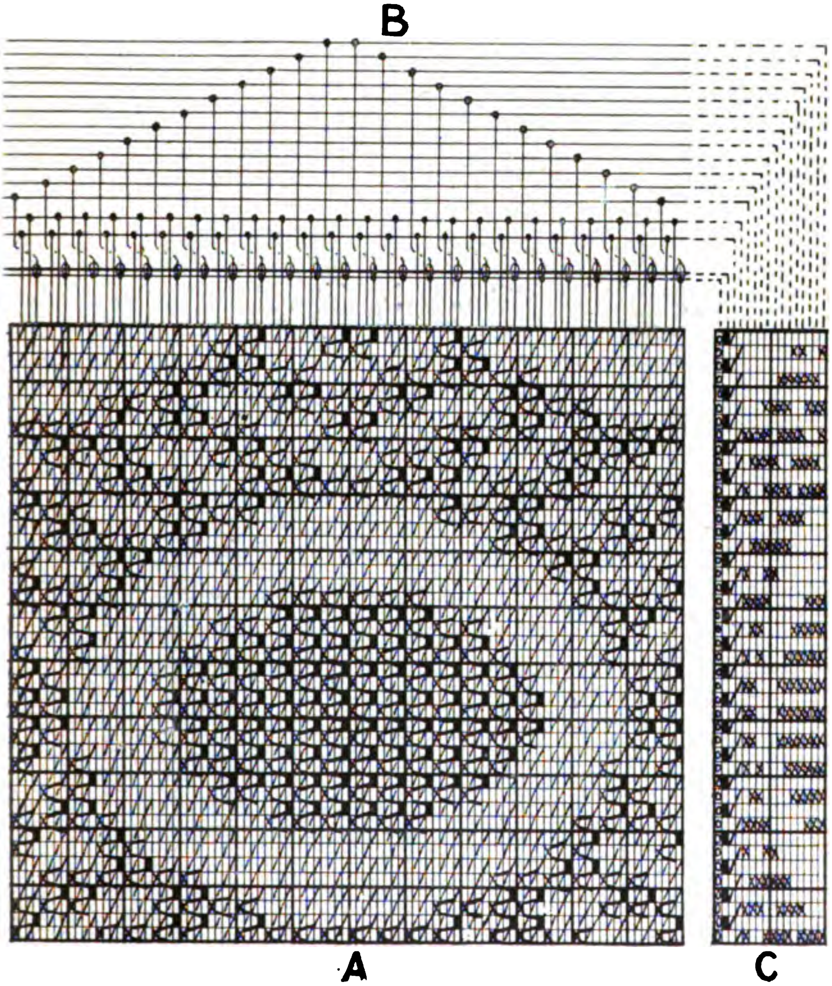

Fig. 280.

at C and D, and two heald drafts E and F are shown, either of which can be employed in producing the effects. A lifting plan is shown on each side of each flat view; G, corresponding with A and C, and H with B and D if the draft E is employed, while with the draft F, I corresponds with A and C, and J with B and D. In the plans G, H, I, and J, the full squares indicate the lifts of the front crossing heald, which is raised on alternate picks, and the circles the lifts of the doup which is raised on every pick. The crosses show where the back crossing healds are raised in forming the gauze ground, and the dots the lifts of the same healds where warp figure is produced; while the vertical strokes indicate the lifts of the standard healds. In comparing the lifting plans with the designs A and B, it is necessary to keep in mind that all the crossing ends are raised by the front crossing heald and doup on the even picks, therefore on these picks no other healds are raised in G and I, and only certain standard healds (where figure is formed) in H and J. The ends should be studied in pairs, 1 and 2 together, 3 and 4 together, etc., and it will be seen that gauze is formed by lifting a back-crossing heald alternately with the front crossing heald, whereas a standard heald is lifted alternately with the latter in producing plain weave. By raising a standard heald on the cross sheds (the even picks), and both standard and back crossing healds on the open sheds (the odd picks), warp figure is formed on the upper side of the cloth, a weft figure being produced in this system by weaving the cloth wrong side up. The lifting of a back crossing heald in forming the figure causes a crossing end to pass temporarily to the open shed side of its standard end, but the latter is raised at the same time so that there is nothing to prevent the crossing end from slipping back when the following crossed shed is made. Therefore, in the figure and plain portion of the design all the crossing ends weave continuously on the crossed side of the standard ends.

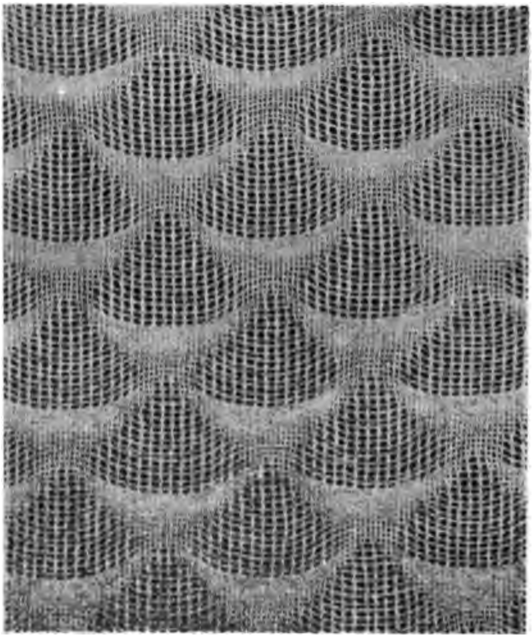

Fig. 281.

The principles of gauze weaving, illustrated in Fig. 282, are employed for a class of figured gauzes produced in jacquard machines; and in weaving the effects shown at A and B in a jacquard mounting the plans for the card cutting would be as shown at G and H, or as at I and J, according to the arrangement of the harness draft. One purpose of the illustrations given in Fig. 282 is to demonstrate that the construction of the design or lifting plan for a given effect is much simpler with the transposed draft F than when the straight draft E is employed. It will be noted in the flat views C and D that in the plain and figure portions the standard ends are the odd ends, and the crossing ends the even ends. In the draft E, however, the odd (standard) ends are drawn on the even shafts, and the even (crossing) ends on the odd shafts. It is therefore necessary, in constructing the card-cutting or pegging plans, for the ends to be transposed in pairs, the lifts of the odd ends in the figure and plain being indicated on the even vertical spaces of G and H, and of the even ends on the odd vertical spaces. At the same time it has to be taken into account that the back crossing healds (the odd shafts) must not be raised on the cross sheds (the even picks). In the draft F, however, the ends are

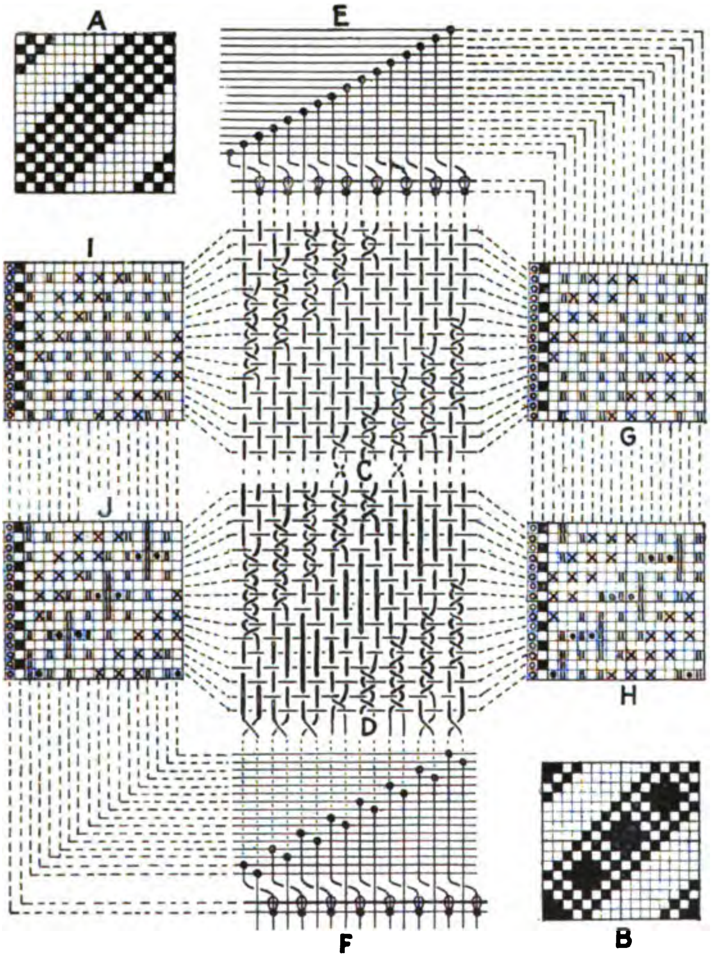

Fig. 282.

transposed in pairs in the healds, the odd (standard) ends being drawn on the odd shafts and the even (crossing) ends on the even shafts. Therefore, in this case, the plans I and J exactly correspond with the designs A and B, except that the lifts, obtained by raising the front crossing heald, are omitted, and marks are inserted, as shown by the crosses, in the gauze ground.

CHAPTER XIII

JACQUARD GAUZE AND LENO FABRICS

Ordinary Jacquard and Doup-Heald Mountings—Styles of Cloth—Combinations of Gauze, Plain Weave, and Warp (or Weft) Figure—One-crossing-one Styles—Special Ground Weaves—One-crossing-two Styles—Use of Two Doups—Modification of Gauze Ground—Net-Leno Figured Styles—One-crossing-three Patterns—Combinations of Twill and Gauze. *The Special Gauze Jacquard and Harness*—Arrangement of Harness, Hooks, and Needles—System of Drafting—Method of Douping and Easing—Construction of Gauze Ground Weaves—Designing of Figures—System of Card-cutting—Top Douping in the Gauze Harness. MADRAS GAUZE FABRICS—Structure of the Cloth—*The Madras Loom*—System of Drafting—Method of Crossing the Ends—Method of Easing—Arrangement of Shuttle Boxes—Operation of the Gauze Reed—Operation of the Easing Bar—Operation of the Tug Reed—The Picking Motion—The Up-take Motion—*Madras Designing*—Modifications of the Structure—Single Cover Chintzed Design—Gauze Figure on Opaque Ground—Complex Three-colour Fabric—System of Card-cutting.

THERE are three chief systems of mounting for jacquard gauze effects, viz. :—(1) An ordinary jacquard and harness working in combination with one or more doup healds ; (2) a special jacquard and harness in which there are extra needles, hooks, and cords for effecting the douping and easing ; (3) a Madras jacquard and harness in which the crossing of the ends is effected by means of a special gauze reed.

ORDINARY JACQUARD AND DOUP-HEALD MOUNTINGS

The alterations and additions, required in changing from straight interlacing to gauze, are practically the same in an ordinary jacquard and harness as in heald work. The doup and doup heald are placed in front of the harness, which is moved a sufficient distance back from its usual position to allow the shafts to be operated in front of the comber-board. The healds may be operated by tappets, but it is usually more convenient to make use of special front hooks at each side of the jacquard, in order to give a straight lift to the healds. In the case of a heavy doup lift, several hooks at each side may be employed to lift the doup heald, duplicate holes being cut in the cards to correspond. In many cases the lifting of the healds may be simplified by connections being made from them to the jacquard griffes. Thus, in a single-lift machine, if the half heald is required to be raised on every pick, it may be connected to the griffe, whereas in a double-lift jacquard, if the doup heald is required up on alternate picks, it may be connected to one griffe, and the half-heald to both griffes. In the latter case, the half-heald is lowered to the centre of the shed for the crossing at each pick. Spiral springs are used to draw down the healds, while the easing is effected by means of a transverse bar, as in heald work, the extremity of the easing lever being connected to the same hooks or griffe as the doup heald, or to separate hooks at the back of the machine. It is advisable to have the doup heald and easer operated from the same source, and if separate hooks are used, the same needle should control both. This makes it impossible for a cross shed to be formed without the easing being effected at the same time. If the repeat of the lift of the doup heald is on two or four picks, it is convenient to cut holes in every card opposite the needles which control the healds and easer, pegs being then inserted in the corresponding holes in the cylinder to act in place of blanks in the cards.

Single-lift jacquards are generally found most convenient in figured gauze weaving, particularly in producing fabrics for which, in double-lift shedding, a shaker motion would be required. In arranging to weave designs in double-lift jacquards, it is necessary to carefully consider the type of gauze structure to be formed. The styles that are most suitable are those which require no shaker motion, as, for instance, fabrics in which the standard ends work continuously in plain order, or in which one or more picks are inserted between the crossed and open sheds. Although seldom employed, shaker motions have been devised for double-lift jacquards, and in one method the bannister harness principle is adopted, wood staves being passed through loops formed in the standard harness. The loops are made long enough to allow the ordinary lifts of the harness to be made, while by means of a tappet the staves are raised a distance equal to half the height of the shed. The standard ends left down by the harness are thus raised to the centre. In another method the knotted comber-board principle is employed, large knots being made in the standard harness in such a position that they rest on a supplementary board placed above the ordinary one. The knots do not prevent the standard ends from being raised in the usual manner, while by giving a half shed lift to the upper board the ends are raised to the centre.

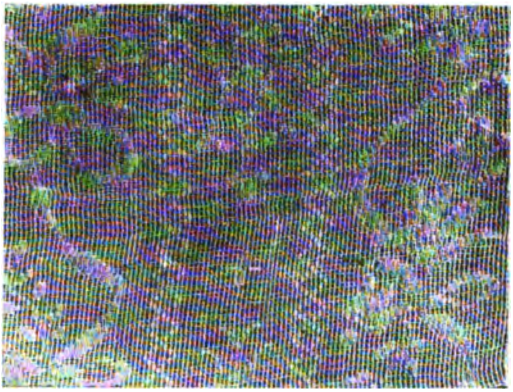

Fig. 283.

Styles of Cloth.—The principal styles of cloth produced in an ordinary jacquard with a doup in front consist of:—(1) Gauze or leno combined in stripe form with figured effects; (2) combinations of ordinary weave and gauze, one of which forms the figure and the other the ground; (3) combinations of ordinary weave, warp (or weft) figure, and gauze. The first style calls for no special attention, since the same ends are not required to form successively both figure and gauze. Examples of the second and third styles have been described in relation to dobby effects, and illustrated in Figs. 275 to 282; and the same principles apply to jacquard patterns, except that in one case a pegging plan is required and in the other case a card-cutting plan. The crossed interlacing that is produced may consist of a light, open formation, or of a rather heavy net-leno structure.

Combinations of Gauze, Plain Weave, and Warp (or Weft) Figure.—Examples of this type of structure are given in Figs. 283 and 284, the former illustration representing a combination of gauze and plain weave, while in the latter, weft figure on the right side of the cloth is also included.

One-crossing-one Styles.—The method of designing for structures in which one end crosses one end is illustrated in Fig. 285. (These examples show the jacquard development of the styles given in Fig. 282.) A in Fig. 285 represents a harness and doup-heald draft, in which the ends are transposed in pairs—2, 1, 4, 3, etc.—in order that the standard and crossing ends, which respectively form the odd and even ends in the plain and figure portions of the cloth, will correspond with the odd and even spaces respectively of the design paper. The plans B, C, and D illustrate the designing of a plain weave figure on gauze ground, such as is represented in Fig. 283, while E, F, and G show the designing of a warp (or weft) figure—surrounded by plain weave—on gauze ground; this style corresponding with Fig. 284. The lifts of the doup and doup heald are indicated at the side of the plans, and in both styles, on the even picks, all the crossing ends are raised by the doup heald on the right-hand side of the standard ends. The picks—odd or even—on which to form the crossed sheds is determined by the position of the plain marks on the even ends; thus, if the plain weave had been indicated in the reverse position in the plans B and E, the lift of the doup heald would have occurred on the odd picks.

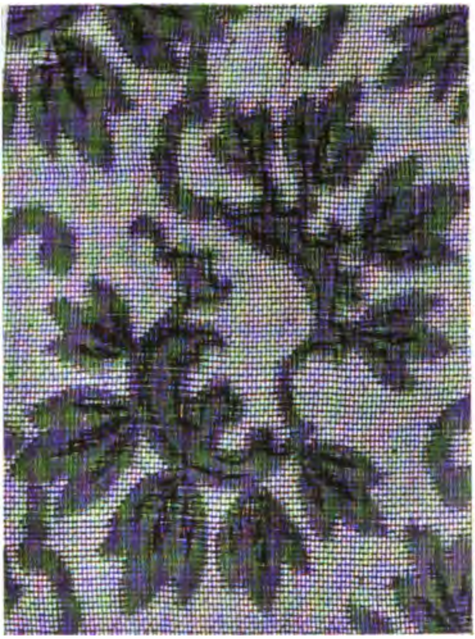
Fig. 284.

The plan B in Fig. 285 represents the form of a plain weave figure as actually required in the cloth, while C shows the effect indicated in full for the card-cutting. Since the doup heald, on the even picks, lifts all the crossing ends on the right of the standard ends, no ends are raised by the harness on these picks, the cards for which are blank except where holes are cut for the purpose of lifting the doup heald. On the odd picks the standard harness lifts the standard ends where the plain figure is required, as shown by the full squares in C; while the crossing harness lifts the crossing ends in the gauze ground, as indicated by the crosses. The blank picks need not, however, be included in the design, as the cards for these can be obtained by repeating, hence the drafting of a gauze and plain combination may be simplified by designing for the open sheds only, as shown at D. In this case the outline of the figure is first drawn in the ordinary manner on design paper, the counts of which is in the proportion of the ends per inch to the picks per inch divided by two. Then the odd vertical spaces are filled in where the plain weave is required, as shown by the full squares in D, and the even vertical spaces for the gauze effect, as indicated by the crosses. The ends require to be followed in pairs, 1 and 2 together, 3 and 4 together, etc., and an examination of D will show that the full squares and crosses always succeed each other. Where there are two marks or two blanks alongside each other on the same pick, they belong to different pairs of ends.

When the system of designing, shown at D in Fig. 285, is employed for a combination of plain weave and gauze, very little advantage is gained by using the transposed harness draft A, as compared with a straight harness draft, as the only difference is that with the straight draft the plain effect is indicated on the even vertical spaces and the gauze on the odd vertical spaces. In the case of designing a warp (or weft) figure, however, the transposed draft is much more convenient than the straight draft, as with the latter it is necessary in the figure for the working of the odd ends to be indicated on the even vertical spaces, and of the even ends on the odd vertical spaces. This has been illustrated in Fig. 282, so that no further reference is necessary. In Fig. 285 the plans E, F, and G show, step by step, the process of drafting a figure, assuming that the transposed harness draft A is employed. In this style it is necessary for every card to be cut from the design, because certain standard ends require to be raised on the doup sheds, in addition to the crossing ends. The figure, with two or more threads of plain weave surrounding it, may first be indicated in full in the ordinary manner, as shown at E, the floats of the figure being carefully arranged to fit with the plain weave. The insertion of plain weave round the figure is necessary in order that the change from the firm gauze

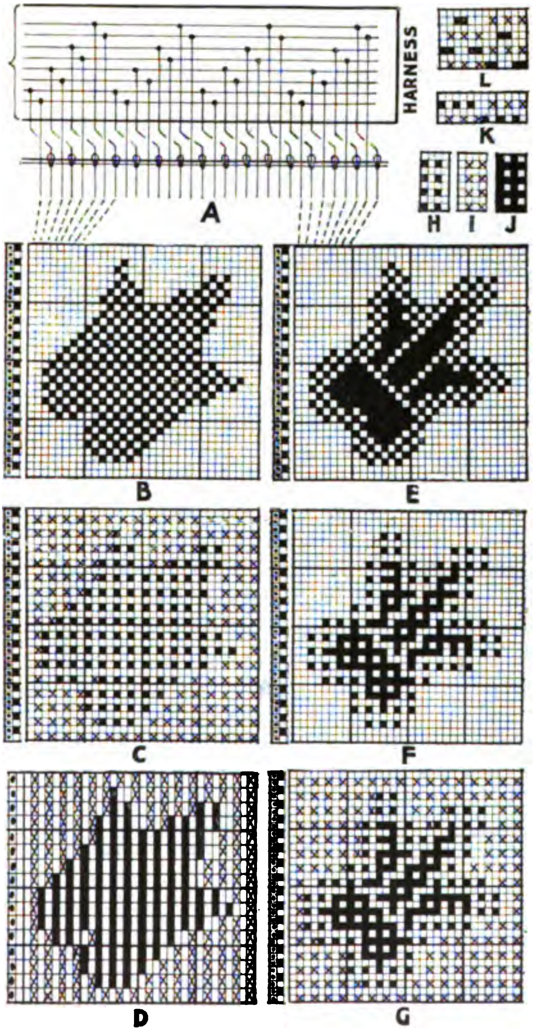

Fig. 285.

structure to the loose figure will be gradual, and so enable the threads to spread. The next stage, shown at F, consists of taking out (or indicating in a different colour) the marks where the even ends and even picks intersect, as these lifts are produced by raising the doup heald. In the final stage, shown at G, the ends are followed in pairs, and marks are inserted on the odd picks where the crossing ends require to be raised by the harness in forming the gauze ground, For convenience, the jacquard weaves which produce the three effects are shown separately at H, I, and J, the plain weave being formed by H, the gauze by I, and the warp figure by J, the doup heald being raised in each case on the even picks. It will be seen in J that where a crossing end, in forming the figuring floats, is raised by the harness on the odd picks, the accompanying standard end is also raised, so that no binding of the ends takes place. The blank spaces on the even picks of J correspond to warp float because the crossing ends are raised by the doup heald at these places.

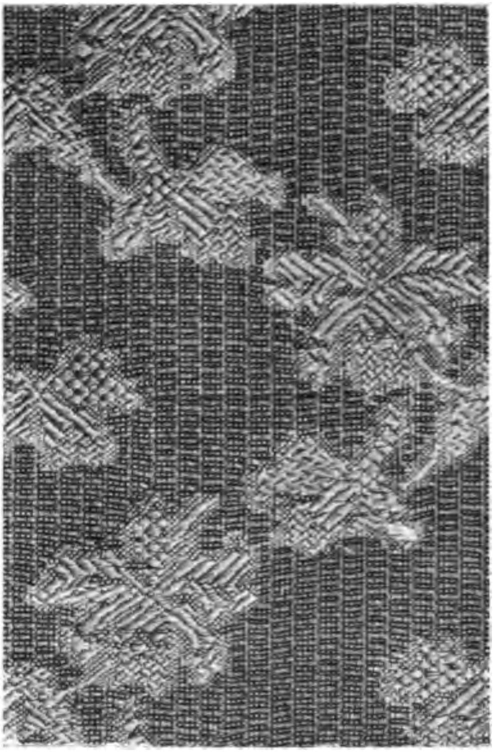

Fig. 286.

Special Ground Weaves.—With the pure gauze ground only very open structures can be produced, and sometimes sufficient picks cannot be inserted to form a good structure in the figured portion of the cloth. Examples of ground weaves are given at K and L in Fig. 285, which enable more picks to be put in, as each pair of ends only forms the crossed interlacing once in every four picks. By using the first four ends of either weave a ground structure is formed in which three picks of every four are readily grouped together, while by employing the full weaves a kind of spider's web ground effect is produced, similar to the styles illustrated in Figs. 277 and 278 (p. 254).

A figured fabric, in which a spider's web ground is formed, is represented in Fig. 286, while the order in which the threads interlace in the ground, together with the harness and doup draft, is given in Fig. 287. The system of preparing the design for the card-cutting, is illustrated in Fig. 288, in which the portion lettered A shows the figure indicated in full, and that lettered B, one complete repeat of the ground weave. In a portion of the figure diagonal marks are shown which represent figuring marks taken out where the even ends intersect the even picks, in order to prevent the crossing ends from being raised at the same time by both the harness and the doup heald. The following are suitable particulars for a cloth in the one-crossing-one style :

Warp 2/60's to 2/80's cotton, 40 to 48 ends per inch. Weft 16's to 20's mohair, 40 to 44 picks per inch.

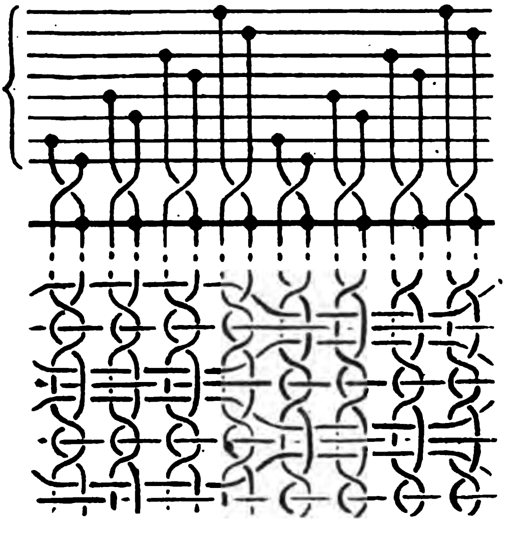

Fig. 287.

If the crossing and standard ends are similar the best results are obtained by placing both series of ends on the same warp beam, but it is advisable to distribute the gauze structure as uniformly as possible in a design in order to equalise the strain on the ends.

One-crossing-two Styles.—The styles which are illustrated in Figs. 283 and 284 are also readily woven with one end crossing two ends, and different methods of producing the effects on this principle are illustrated in Fig. 289. The figure indicated at A, which resembles the form represented in Fig. 285, is used as the motive in each case in order that comparisons may be made. B shows a harness and doup-heald draft, and C the card-cutting plan for producing an opaque figure on gauze ground similar to the effect given in Fig. 283. This style also corresponds with the dobby pattern illustrated in Fig. 280 (p. 255). The doup heald lifts on the even picks, and there are therefore two picks and three ends in each group, so that in indicating the design in full, as shown at C, each small square in the motive A is taken to represent two picks and three ends. The standard ends work plain throughout, and in the plan C, in order to show the form clearly, the weave is represented by full squares in the figure, and by dots in the ground. The crossed interlacing is formed in the ground by lifting the crossing harness on the odd picks, as shown by the crosses.

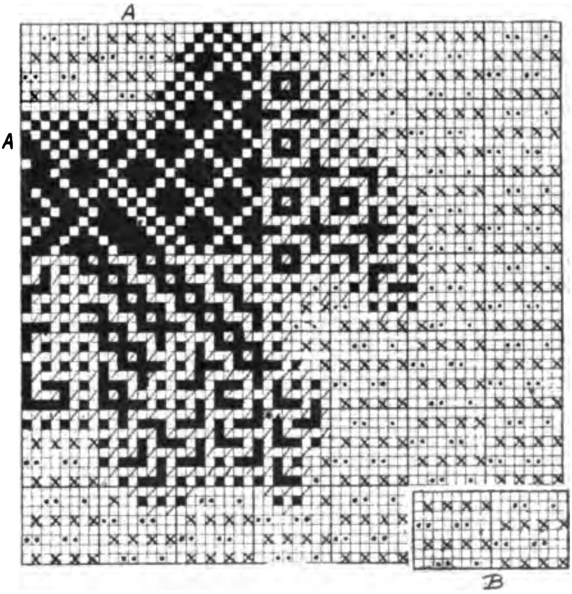

Fig. 288.

In the figure the crossing ends interweave in plain order on the crossed side of the standard ends, but these lifts are not indicated in C, as they are due to

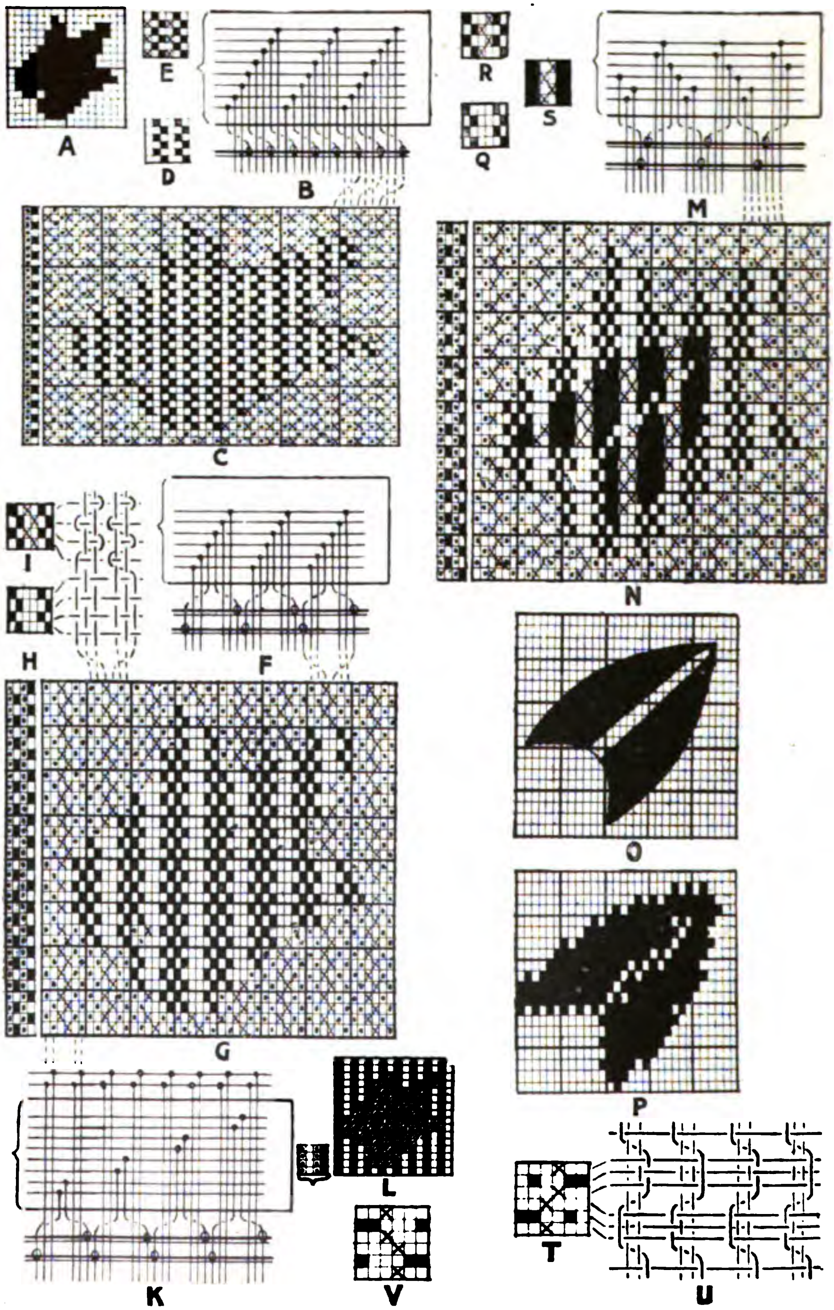

Fig. 289.

the doup heald being raised on the even picks. The respective weaves for the figure and gauze are shown separately at D and E in Fig. 289.

Use of Two Doups.—With the draft given at B in Fig. 289 pure plain weave cannot be formed in the figure, as the first and third ends of each group of three work alike. By using two doup healds, however, with the crossing ends drafted in opposite directions, as shown at F, a figure may be formed in perfect plain weave. The repeat of the draft is on six ends, and in F the harness is represented with the two back rows of cords cast out. All the rows of the harness may, of course, be employed, but the arrangement shown is convenient if the sett of the harness is sufficiently fine. Design paper is then used, which is ruled to correspond. Thus, in G, which shows the complete card-cutting plan to coincide with the motive A, the counts of the paper is 6 by 4 to correspond with a cloth counting, say, 66 ends and 44 picks per inch. The first doup heald lifts on the odd picks, and the second on the even picks, as indicated at the side of G. The standard ends work in plain order continuously, and in the gauze ground the crossing harness is raised where indicated by the crosses. The separate weaves for the plain and gauze are given respectively at H and I, alongside which the interlacing of the threads is represented. The drafting of a design for the card-cutting is simple, as it is only necessary to indicate plain on the design paper, except where the centre two of every six ends are left blank in the plain weave sections of the design. The threads should be followed in groups of three ends and two picks, and a somewhat steppy outline is given to the figure. It should be kept in mind that in the figure the crossing ends do not work plain where the two blank vertical spaces are shown in the design, because the doup healds lift them in plain order in the centre of each group of four standard ends.

An alternative system of drafting, for the style indicated at G, is given at K in Fig. 289, where the plain standard ends are shown drawn on two healds placed behind the harness. A similar draft may be arranged for the single-doup design given at C. An advantage of this arrangement is that, as only the crossing ends are drawn on the harness, a large figure can be produced in a small jacquard ; also the designing and card-cutting are very much simplified. Thus, for the style given at C, a figure may be designed solid, as shown in the motive A. The blanks are then cut if an opaque figure is required on gauze ground, whereas the marks are cut in producing a gauze figure on an opaque ground. The cards cut from the design represent the picks on which the crossing harness is raised (the odd picks in the plan C), and these are laced alternately with the cards for the doup-heald sheds, which are blank, except where holes are cut for the purpose of operating the healds and easer.

In producing the style given at G in Fig. 289, with the draft K, however, all the cards require to be cut from the plan, because in forming the gauze a portion of the crossing harness is raised on the odd picks, and another portion on the even picks. The system of designing, illustrated at L, may be employed, in which the plain effect is indicated by a wash of colour, as represented by the shaded squares; then in the gauze sections alternate vertical spaces are filled in solid in a second colour, as shown by the full squares. The doup lifts may be indicated alongside, as shown in the bracketed portion on the left of the plan L. Two cards are cut from each horizontal space, the blanks being cut in the first card, and the full squares in the second, while the dots alongside, which indicate the lifts of the half-healds, are cut in every card. The ordinary healds, placed at the back of the harness, are operated in plain order throughout. In designing a figure in the manner shown at A and L the counts of the design paper is in the proportion of the ends per inch ÷ 3 to the picks per inch ÷ 2.

If the standard ends are drawn on healds it is only possible to form combinations of gauze and plain weave. In weaving warp (or weft) figure it is necessary for all the ends to be drawn on the harness. The six-row draft, shown at M in Fig. 289, may be employed which varies from the draft F in that the crossing ends are drawn on the opposite side of the standard ends. This is in order that where figure is formed the position of the crossing ends will be the same in the design and cloth, viz., the third and fourth in each group of six. Assuming that a warp figure, similar to that indicated at O. is required to be introduced on the plain shape shown at G, the full card-cutting plan will be as shown at N. The crosses in N show where the crossing ends are raised by the harness, and the chief points to note are: (*a*) Not to lift a crossing end by the harness at the same time that it is raised by a doup heald; (*b*) to lift both the accompanying standard ends where, in forming warp figure, a crossing end is raised by the harness. The latter condition is necessary in order to prevent the crossing ends from being bound in on the open shed side of the standard ends, and it will be found that the floats of a figure must be slightly modified to suit. Thus, the form shown at P will result from the card-cutting plan given at N. The respective weaves for the plain, gauze, and warp figure are shown separately at Q, R, and S in Fig. 289.

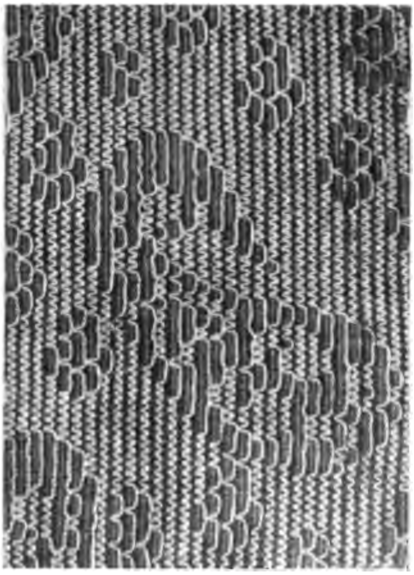

Fig. 290.

Modification of Gauze Ground.—The plan T in Fig. 289 is given as an example of how the gauze structure may be modified in order to enable a larger quantity of yarn to be put into a cloth. The interlacing of the threads is represented at U, and it will be seen that the picks are in groups of three, which makes the gauze formation much more open at the same time that more picks per inch can be inserted. The crossing harness is raised in the order represented by the crosses, and the standard harness as shown by the full squares in T, while the first doup heald is raised the on even picks and the second on the odd picks, as indicated at the side of N. The standard ends interweave somewhat loosely, but the grouping of the picks is largely due to raising both standard ends on the centre pick of each group at the same time that the accompanying crossing end is raised by the doup heald. Each crossing end is thereby caused to interlace for three picks on one side, and then for three picks on the other side of the standard ends. The plan T is arranged to coincide with the draft M, but the same gauze structure may be employed in combination with a purely plain figure, and in that case, if the draft F is employed, the order of lifting will be as shown at V. The plan V coincides with the interlacing of the centre six ends of U, the two doup healds lifting as indicated at the side of G. The ends per inch of these styles may range from 60 in cotton yarns to 100 or more in fine silk yarns, but the picks per inch should not exceed from 40 to 50.

Net-leno Figured Styles.—In forming an *open* gauze structure in the one-crossing-two arrangement all the ends should be similar, and should be brought from one warp beam in order that they will bend equally. By bringing the doup ends from a separate beam that is more lightly weighted than the standard warp beam the crossing ends will be traversed distinctly from side to side of the standard ends which will lie straight. If, moreover, yarn of a special character is employed for the crossing ends, figured net-leno effects, similar to the style shown in Fig. 290, may be formed on the principles illustrated at C and G in Fig. 289.

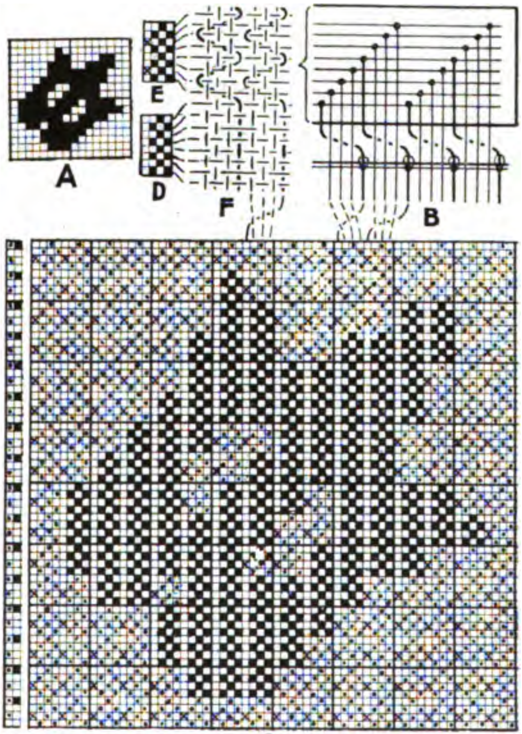

Fig. 291.

One-crossing-three Patterns.—A more prominent pattern, however, is obtained by employing more than two standard ends in each group, and the examples given in Fig. 291 illustrate the production of a figured structure in which one end crosses three standard ends. This style corresponds with the dobby pattern, shown in Fig. 276 (p. 253). The figure indicated at A, which is similar to the form previously shown, is used as the motive, and the harness and doup-heald draft, for producing the cloth wrong side up, is given at B. One doup heald is employed, which is raised on every fourth pick, and in the complete plan of the effect given at C each small square in the motive A is taken to represent four ends and four picks. The standard ends work plain throughout, and the crossed interlacing in the ground is formed by raising the crossing harness on the second of every four picks, as indicated by the crosses in C. The respective weaves of the figure and ground are shown separately at D and E in Fig. 291, while F represents the interlacing of the threads to correspond. In the figure the crossing ends are interwoven in 3-and-1 order on the crossed side of the standard ends by the lifting of the doup heald. Other arrangements of the crossing and standard ends and other orders of lifting may be similarly drafted and designed, but in most cases the working out of a design in full is unnecessary. Thus an examination of C will show that the only picks which vary are the second in each group of four, so that only these picks need be indicated for the card-cutting, the cards for the remaining picks being obtained by repeating. Further, it is possible for the plain standard ends to be drawn on healds, in which case the figure would be indicated solid, as shown in the motive A.

Combinations of Twill and Gauze.—The harness and doup-heald draft, shown at B in Fig. 291, may be employed in combining 2-and-2 twill ordinary weave with gauze two picks in a shed. The style is illustrated in Fig. 292, in which D shows the method of indicating a design for the card-cutting, while E represents how the threads interlace in the bracketed portion of D. This system of grouping the ends and picks in the gauze structure is suitable in producing an open effect when the yarns are somewhat thick and fibrous. The crossing ends are raised by the doup heald on the first and fourth of each group of four picks; in the figure the standard ends form 2-and-2 twill in conjunction with this order of lifting, while the crossing harness is left out of action. In the gauze ground the standard ends are left down, but the crossing ends are raised by the crossing harness on the second and third of each group of four picks. Warp (or weft) figure may be introduced, as in the previous examples, by arranging the floats to fit with the lifts formed by the doup heald.

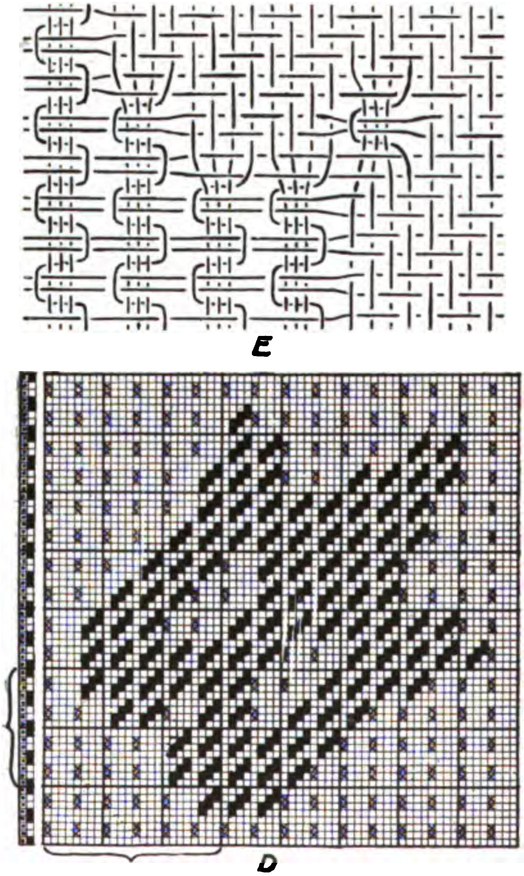

Fig. 292.

The draft, 1-crossing-3, given at B in Fig. 291, may also be used for combinations of 1-and-3 twill weave with gauze in which the picks are grouped 1-and-3. In addition, drafts may be arranged to suit other weaves, as, for instance, 1-crossing-2 for three-thread, 1-crossing-4 for five-thread, and 1-crossing-5 for six-thread effects.

The foregoing examples show that there is considerable scope for producing variety of effect by means of ordinary harness and doup-heald drafts. There are, however, certain limitations in the designing of all-over patterns because the ordinary weave and the gauze must be considered in relation to each other. Thus, gauze—two picks in a shed—may be combined with 2-and-2 warp rib, but it cannot be used along with plain weave because in forming the latter the doup heald must be raised on alternate picks. Weft figure can only be formed in bottom douping by weaving the cloth wrong side up, and it is impossible to produce a figure in both warp and weft float.

THE SPECIAL GAUZE JACQUARD AND HARNESS

A form of this mounting, as made by Messrs. Devoge & Co., is illustrated in Figs. 293 and 294. In place of a doup heald a portion of the harness is used for the douping, and as many independent doup mails are provided as there are groups of crossing and standard ends in a repeat of the machine. Each figuring harness mail in a repeat, as well as each doup mail, may be operated separately, so that in this case there is scarcely any limitation to the different forms and combinations of crossed and straight interlacing that can be produced.

Arrangement of Harness, Hooks, and Needles.—The harness may be divided into three parts, viz., the douping harness A, Fig. 294, the figuring harness B, and the easing harness C. The hooks may similarly be divided into three parts, viz., the douping hooks D, Fig. 293, the figuring hooks E, and the easing hooks F. The needles, however, are only in two series, the top and bottom needles G, each of which controls both a douping and an easing hook, and the central figuring needles H. There are two griffes, the ordinary griffe I, which carries the knives that lift the douping and figuring hooks, and a smaller griffe J, by which the easing hooks are raised.

System of Drafting.—The draft of the ends that is mostly employed, and for which the machine is best adapted, is represented in the lower portion of Fig. 294. An ordinary half-heald or doup K is mounted in front of the harness. The ends are drawn straight over on the mails of the figuring harness B, but the crossing ends are first passed in pairs through the mails of the easing harness C. Each easing mail is provided with two eyes so that the ends are kept separate. Then, in bottom douping, which is represented in Figs. 293 and 294, each pair is drawn under the accompanying standard ends and through the loop of a doup leash which passes loosely through the eye of a doup harness mail A. The half-heald K wears out much more quickly than the harness, and it is in order that the former may be readily replaced that the loose form of doup leash (shown at C in Fig. 236, p. 221) is employed. By comparing the draft with the arrangement of the jacquard and harness it will be seen that in each short row there are 12 hooks, 12 harness cords, and 10 needles for every 8 ends, so that a machine with a capacity of 400 ends requires 500 needles and 600 hooks.

Method of Douping and Easing.—The jacquard is single lift, and the lath of the doup K, Fig. 294, is connected by cords to the griffe I, so that it is lifted on every pick. This enables the crossing ends to be raised either by the doup harness or the figuring harness, while the doup leashes, through which the crossing ends that are not raised pass, simply hang slack beneath the bottom line of the shed. Spiral springs L are employed to reverse the movement of the half-heald. The doup harness cords are passed through a separate comber-board M, Fig. 294, which is placed a short distance in front of the figuring harness, in order to reduce the strain on the crossing ends when a crossed shed is made. The mails of the doup

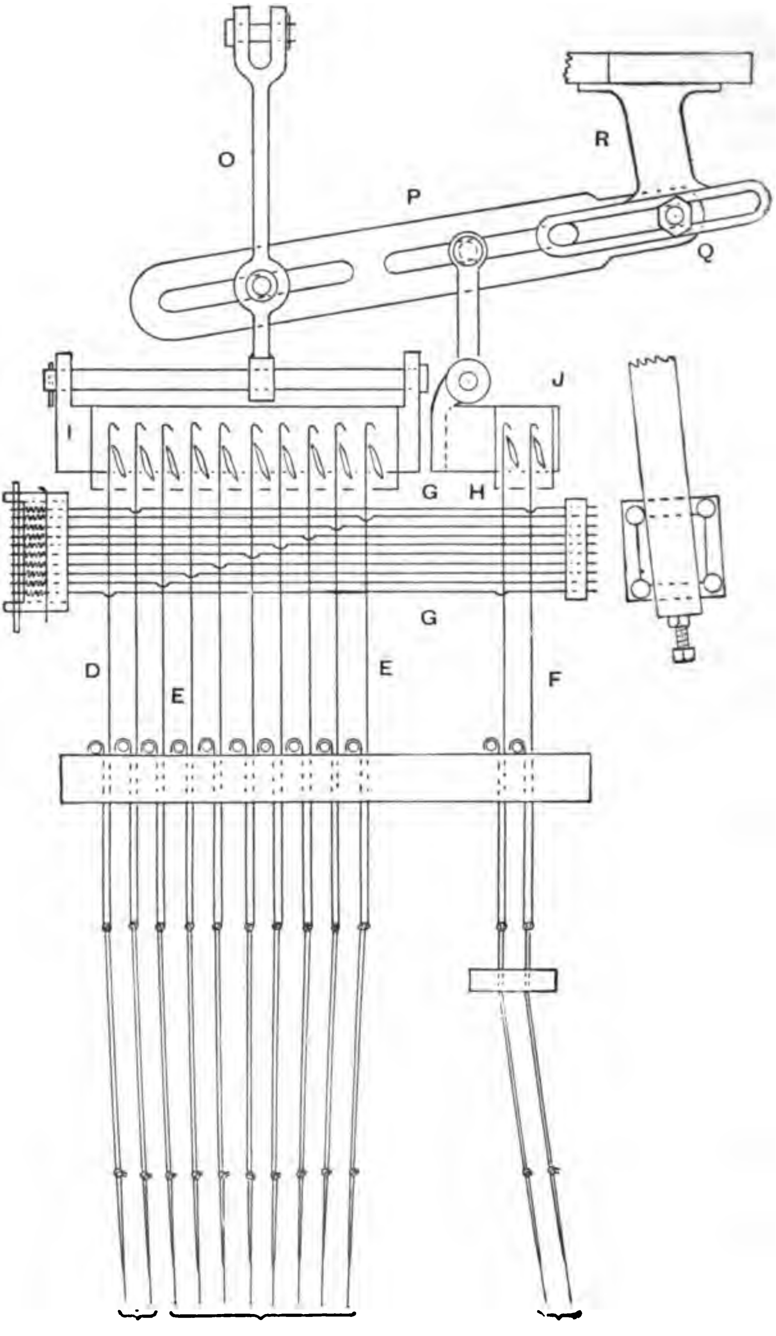

Fig. 293.

harness A are tied up about ¼ inch lower than the mails of the figuring harness B, and they have eyes large enough to enable the doup leashes to slide through them without undue friction.

The griffe I, Fig. 293, which lifts the douping and figuring harness, is operated in the ordinary manner, but to the connecting rod O a slotted lever P is pivotally attached, from which the griffe J is suspended. The lever P is fulcrumed on a stud Q, which is carried by a bracket R supported on the frame of the machine. The rising and falling motion of the rod O imparts a corresponding, but smaller, movement to the griffe J; the extent of the movement of the latter may be regulated by adjusting the studs in the slots of the lever P. The knives of the griffe J are placed rather higher than those of the griffe I, in order that the lift of the easing harness will be slightly in advance of that of the douping and figuring harness.

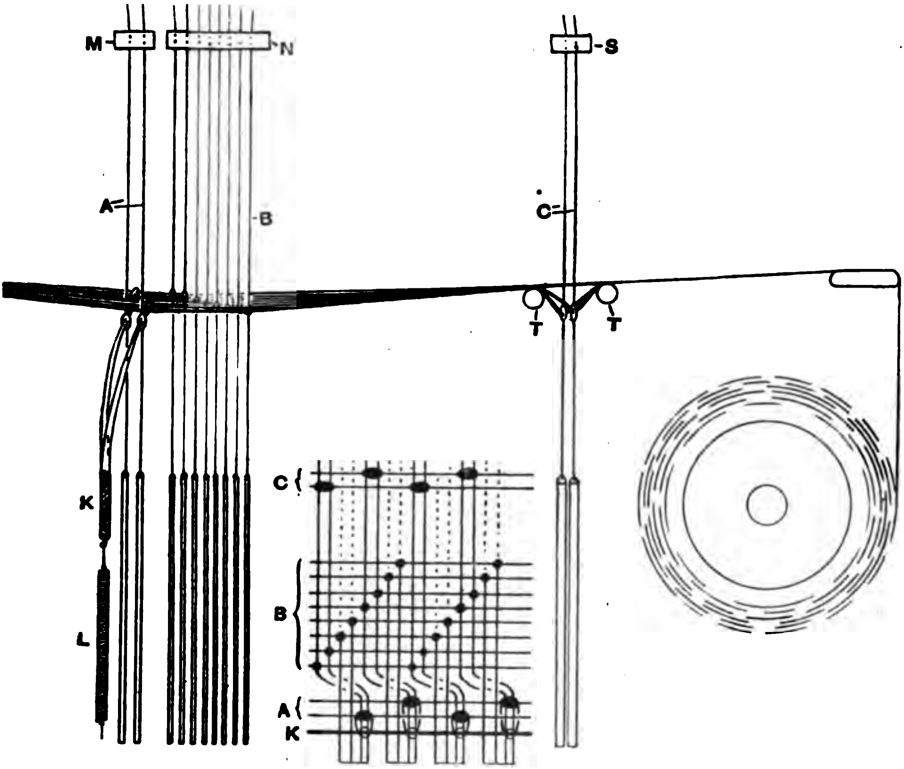

Fig. 294.

The easing harness cords are passed through a comber-board S, Fig. 294, about 10 inches behind the figuring harness, and the mails are tied up so as to depress the crossing ends between two adjustable rods T. Where the easing harness is raised the corresponding crossing ends are, therefore, slackened, and as a douping hook also controls an easing hook, an easing harness cord is raised whenever the corresponding doup harness cord is raised. A length of the crossing warp is, therefore, always given in where a crossed shed is made. The easing harness lingoes require to be very heavy, about 8 to the pound being the usual size, as compared with about 25 to the pound of the douping and figuring harness lingoes.

Construction of Gauze Ground Weaves.—Typical examples of gauze ground weaves, as produced in bottom douping, 2-crossing-2, are represented at A, B, C, D, and E in Fig. 295. In the corresponding plans given alongside, the figuring harness lifts are indicated by the full squares, and the doup harness lifts by the dots. The crossing ends, which are shown in thicker lines in the drawings, are raised by the figuring harness on the left of the standard ends, and by the doup harness on the right. When raised by the doup harness the crossing ends must be lifted in pairs ; in the drawing A these ends are also shown raised in pairs by the figuring harness. If this order of lifting is continued for a considerable space

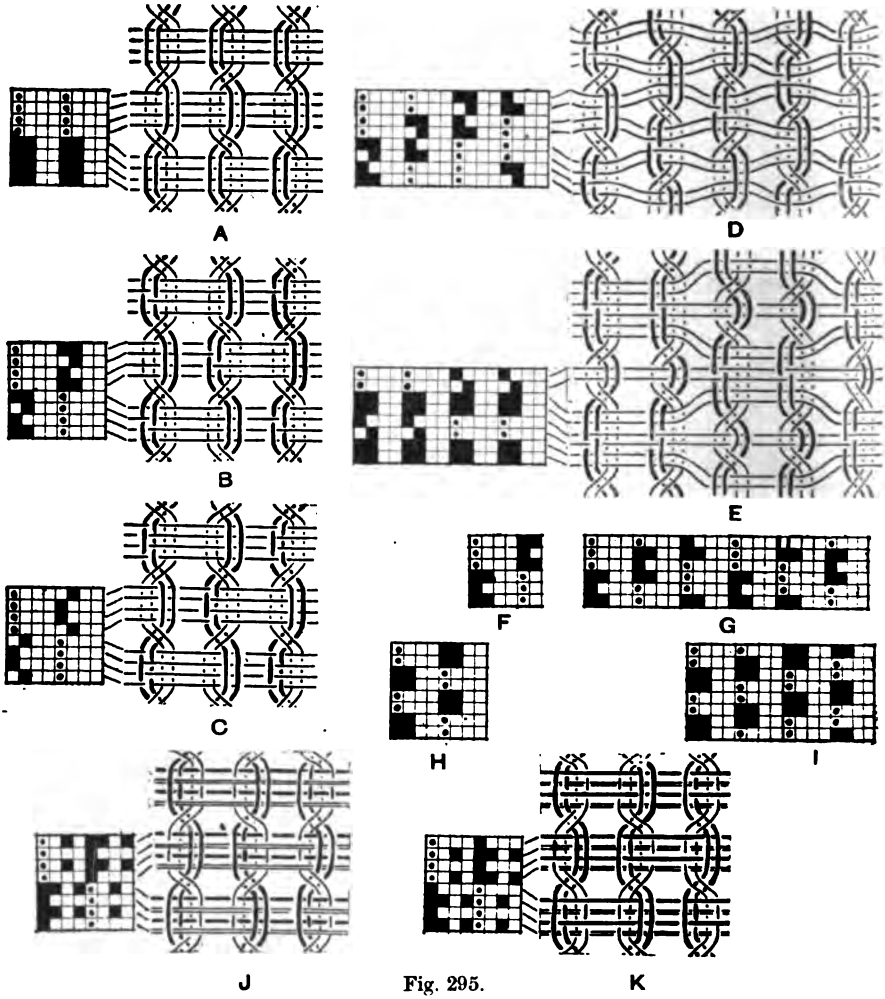

Fig. 295.

the crossing ends (which are passed in pairs through the doup mails) tend to roll round each other, and it is then difficult to form a clear shed in the ordinary weave portions of the cloth where the ends require to be raised separately. For this reason it is better to operate the crossing ends individually on one or more of the figuring harness sheds, which may be accomplished in the manner shown at B and C in Fig. 295. Another point to note is that in forming the gauze shown at A the sheds are either all crossed or all open, whereas in B and C one half the sheds are crossed and the other half open, the strain on the warp and the harness being better distributed in the latter. D and E illustrate different methods of varying the gauze structure by distorting the picks, while the plans F, G, H, and I show other useful examples of gauze weaves. With the plan F the picks

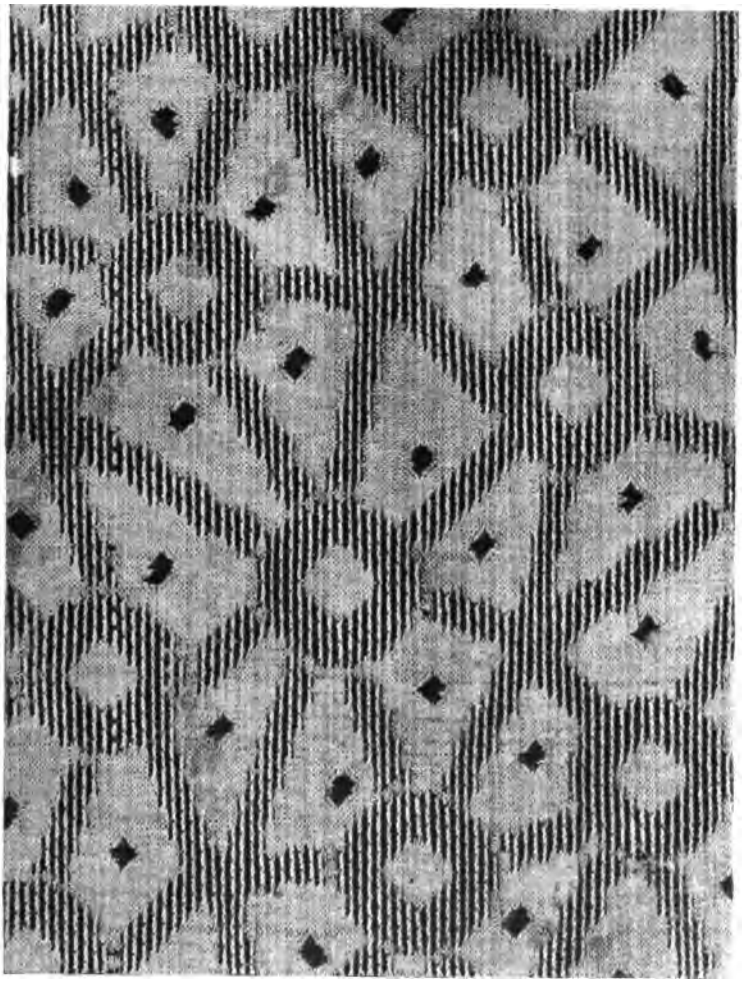

Fig. 296.

are grouped in threes, and with H in pairs; G and I produce modifications of these in which the picks are distorted.

The examples J and K in Fig. 295, and the corresponding plans alongside, show how the gauze structure may be modified to suit a pick-and-pick order of wefting. The crossing and standard ends are interwoven in such a manner that in J the odd picks are shown prominently on the surface, and in K the even picks.

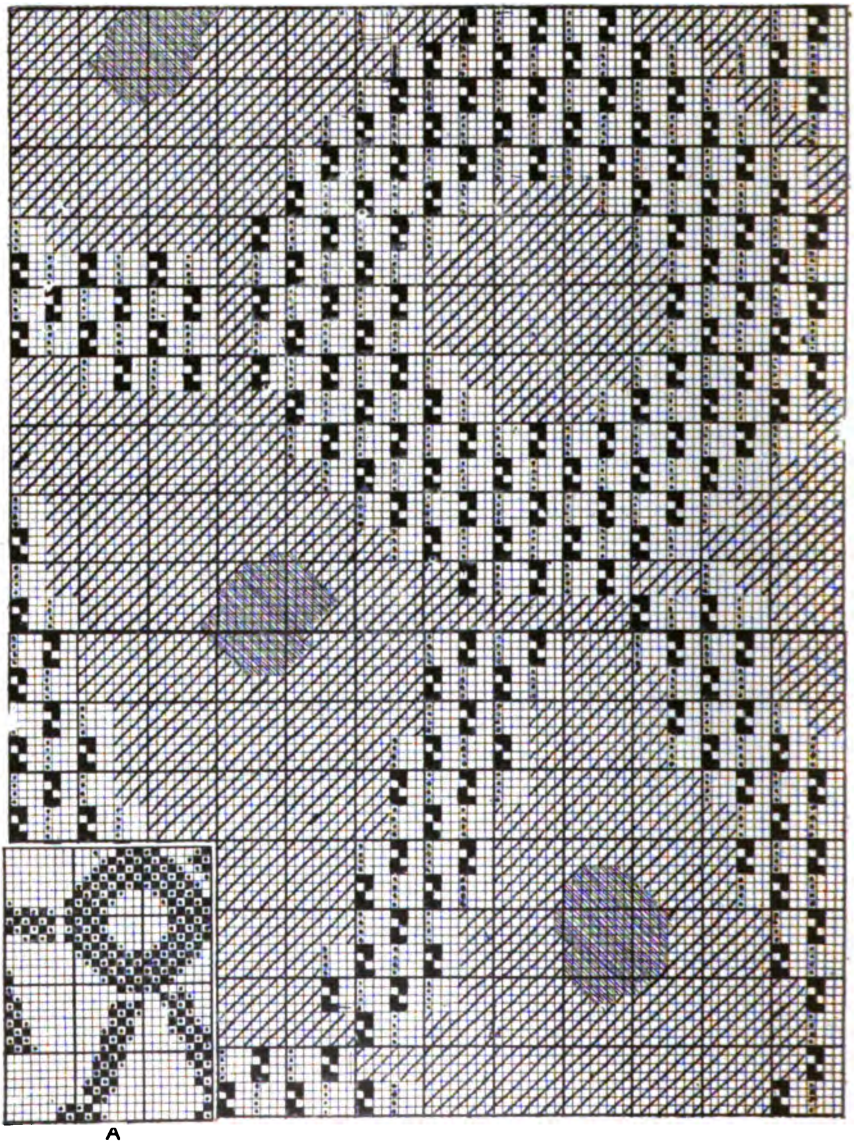

Fig. 297.

The two effects may be combined in the same design and be used in conjunction with a figure woven in two colours of weft.

Designing of Figures.—In the ordinary weave sections of a cloth, either warp or weft or both warp and weft figure may be formed, but in order that the ends will spread it is customary to surround the floats with plain or other firm weave. An illustration of a cloth, in which a figure in gauze is formed on plain ground with weft spots on the latter, is given in Fig. 296, while Fig. 297 shows a portion of the design indicated on design paper. In order that the design may be more readily followed, a reduced plan of the gauze figure is inset at A, each small square in which represents four ends and four picks of the enlarged design, the full squares indicating the open gauze sheds, and the dots the crossed sheds.

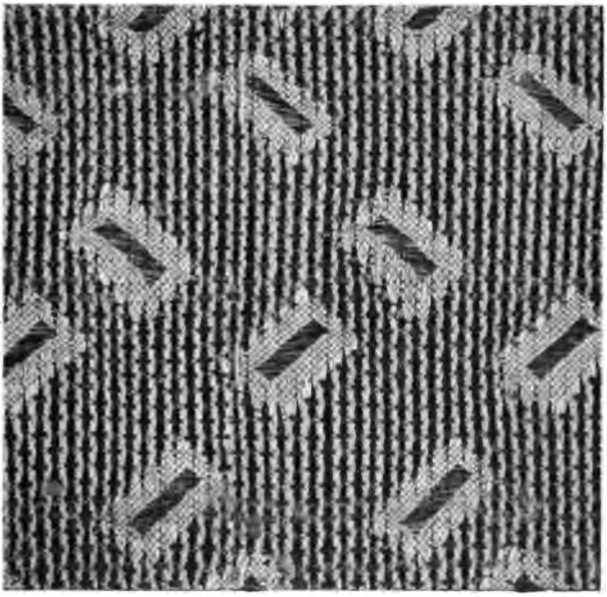

Fig. 298.

The gauze interlacing is similar to that shown at B in Fig. 295, and in the enlarged design the full squares show where the crossing ends are raised by the figuring harness on the open gauze sheds, and the dots where the same threads are raised by the doup harness. The plain weave is represented by diagonal strokes, in order that it will show in contrast with the marking of the gauze, while the weft figure is indicated by the shaded squares. The edge of the gauze figure is in steps of four-by-four, in order that it will fit with the four-by-four grouping of the warp and weft threads. This is quite right when, as in the example, the gauze forms the figure, but in the case of the gauze forming the ground the steppiness, where the gauze and the ordinary weave join, should be reduced as much as possible. In the two-crossing-two arrangement the ordinary weave must step four ends at each place, but in the weft the gauze weave may be modified at the junctions, so as to make the outline of the figure more regular.

Fig. 298 shows an effect in which a weft figure, surrounded by plain weave, is formed on a gauze ground, the interlacing in which is similar to the style represented at C in Fig. 295. In drafting a design the figure and plain weave may be painted in in the ordinary manner, and either warp or weft may be indicated. Both methods are illustrated in Fig. 299, which shows a sectional plan of the design given in Fig. 298, as produced in bottom douping. If the warp is painted, as shown at B, a weft figure may be indicated by leaving the squares blank, or be represented by a different colour to that used for the warp lifts. In the latter case the plain weave is inserted right against the figure, as shown in B, and also in Fig. 297. In the gauze ground the lifts of the crossing ends by the figuring harness are indicated on the first and second of each group of four ends, as shown by the full squares in B, while the doup harness lifts are indicated in a different colour on the first of each group, as shown by the dots. Where the gauze and plain weave join it is necessary to consider the ends in groups of four, as it is impossible to have, say, two ends working plain and two ends forming gauze. It is necessary, also, to keep in mind that the gauze and the ordinary weave are clearly separated from each other only where a doup harness lift (a crossed shed) precedes or follows the ordinary weave. It is a good system to insert doup harness lifts along the outline as near to the ordinary weave as possible where the corresponding standard ends are left down; the ordinary weave and the gauze may then be modified to fit with these lifts.

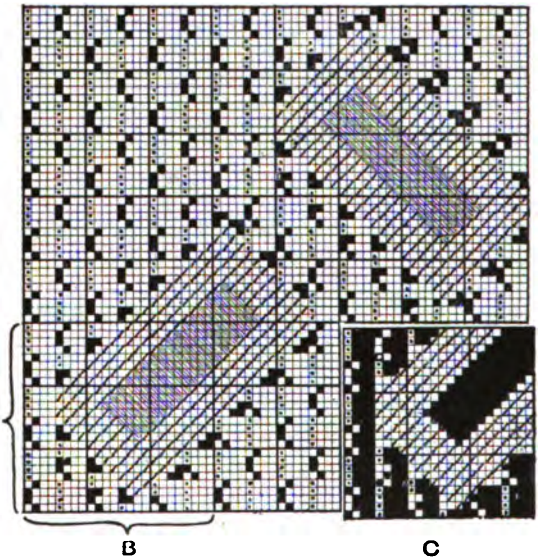

Fig. 299.

If the weft is painted, as indicated at C in Fig. 299 (this plan corresponds with the bracketed portion of B), the standard ends are all marked down in the gauze ground, and marks are inserted where the crossing ends are left down by the figuring harness. The doup harness lifts are indicated in the same manner as in painting for warp, and except for these lifts C is exactly the opposite of B. A comparison of B and C will show that in bottom douping painting for warp is more convenient than painting for weft, because fewer marks are required in the former method, and to the designer who is accustomed to other forms of gauze designing, the lifts are more readily reasoned out.

System of Card-cutting.—It has been previously noted that in each row of the machine there are 10 needles and 8 ends; in the card-cutting, therefore, a 10-rowed card has to be cut from a design which is ruled in eights. With the system of designing, shown in Figs. 297 and 299, this presents no difficulty, as the ordinary marks of the design, which indicate the lifts of the figuring harness, are cut on the middle eight rows of the card, while the special marks, represented by dots, which show the lifts of the doup harness, are cut on the first and tenth rows. That is, dots on the first vertical space are cut on the first row and on the fifth vertical space on the tenth row. If the weft is painted, as shown at C in Fig. 299, the only difference is that the blanks are cut on the middle eight rows of the card.

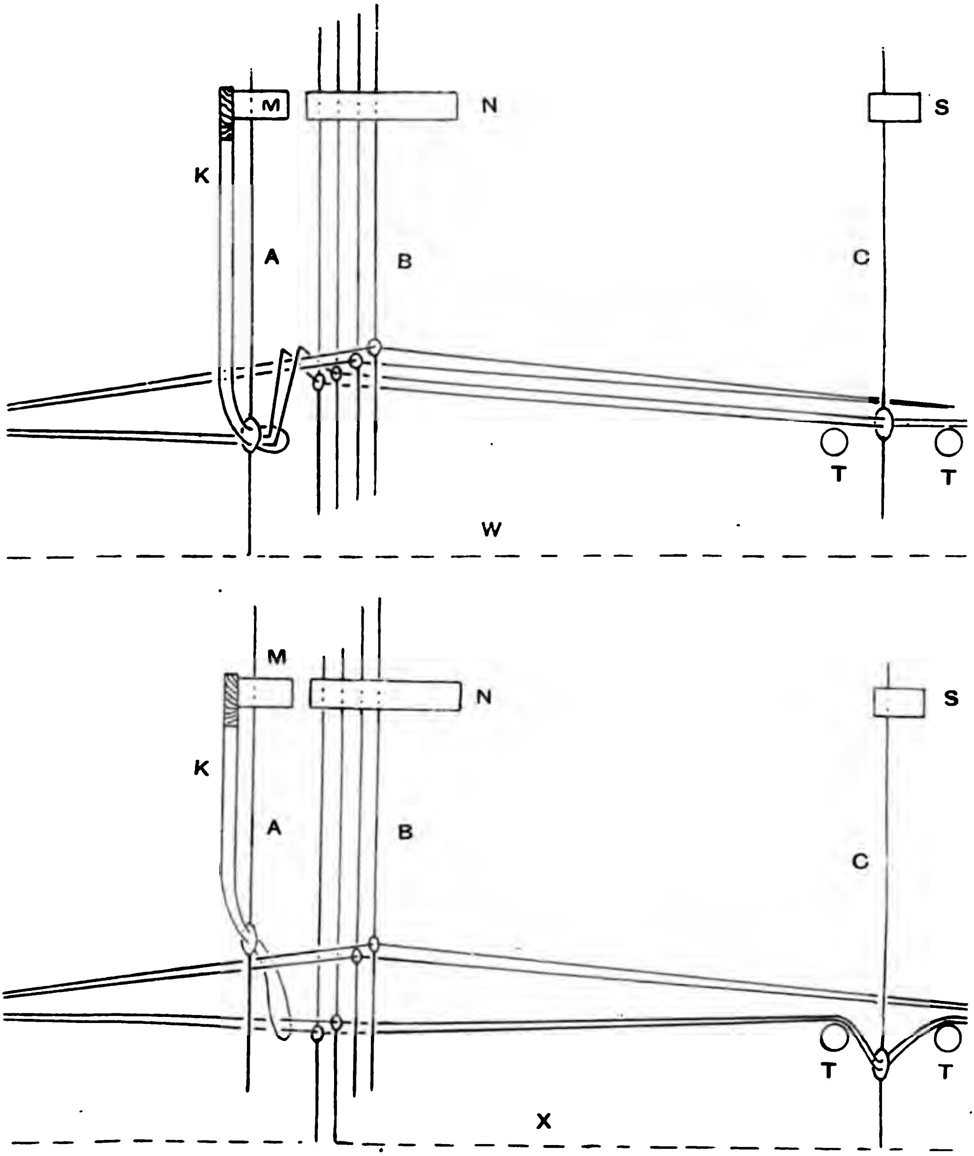

Fig. 300.

Top Douping in the Gauze Harness.—This system is only employed to a limited extent as compared with bottom douping. It has the advantage that the doup leashes cannot fall out of reach of the operative, and are in a convenient position for repairs to be effected; the jacquard and harness lift, however, is much heavier than in bottom douping. The lath of the half-heald in this case is usually fixed to the front of the doup harness comber-board. The doup harness mails are tied up about ¼ inch higher than the figuring harness mails, while specially heavy doup

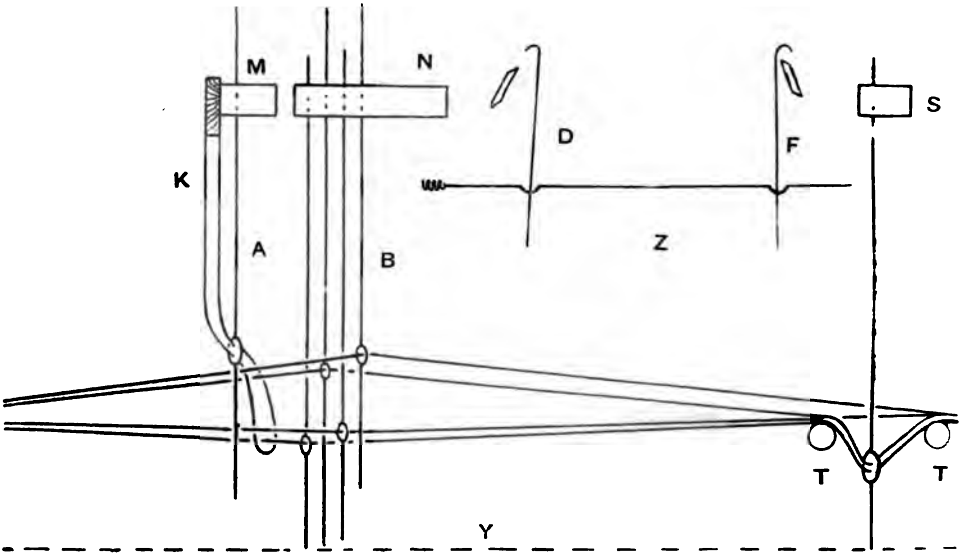

Fig. 301.

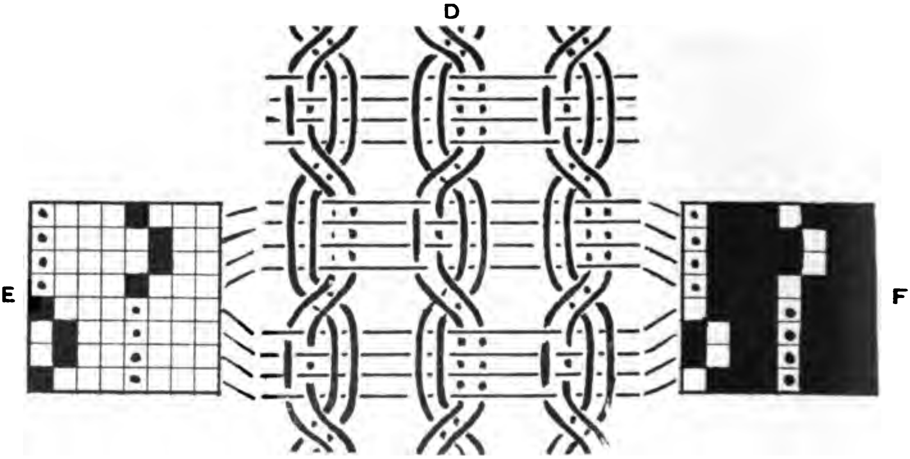

Fig. 302.

harness lingoes are employed. The draft is the same as in bottom douping, except that the crossing ends are drawn over the standard ends.

The different sheds, as formed by a group of four ends, are illustrated in Figs. 300 and 301, from which an idea of the various lifts will be obtained; the parts are lettered to coincide with Figs. 293 and 294. The drawing W in Fig. 300 represents the formation of a crossed shed, in which both the crossing and the standard ends are raised by the figuring harness B. The easing harness C is also raised, but the doup harness A is left down. As the shed is being formed the crossing ends are retained by the doup harness on the crossed side of the standard ends.

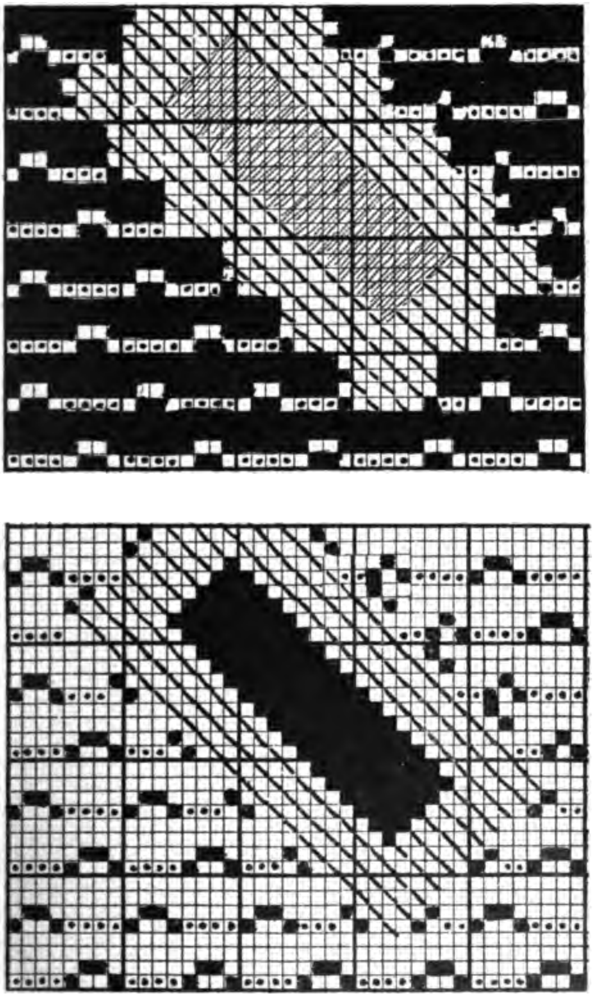

Fig. 302A.

The drawing X in Fig. 300 represents the formation of an open gauze shed, in which only the standard ends are raised by the figuring harness B; the doup harness A is also raised, but the easing harness C is left down. The crossing ends are retained by the figuring harness on the open side of the standard ends, while the mails of the doup harness are slipped up the half-heald leashes; each pair of standard ends is raised between a leash of the doup and a doup harness cord.

At Y in Fig. 301 the formation of a figure or plain shed is represented, which is very similar to an open gauze shed. The figuring harness mails are lifted where required (as in ordinary figuring), the doup harness A is raised, and the easing harness C left down. Lifting the doup harness enables the crossing ends to be raised by the figuring harness without obstruction. If one crossing end of a pair is required down and the other up, the latter slides within a loop of the half-heald, as shown in Y, but if both crossing ends are raised the loop is carried to the upper line of the shed.

It will be noted in top douping that when the doup harness is raised the easing harness is left down, and *vice versa*. The same needle controls both a douping and an easing hook, and it is therefore necessary for one series of hooks and lifting knives to be turned the opposite way to the other series. Either series may be inverted, but for convenience in the designing and card-cutting it is better to reverse the doup needles and knives, in the manner represented at Z in Fig. 301. The card-cutting particulars are then the same as in bottom douping, holes being cut for the cross sheds, and blanks left for the open sheds on the first and tenth rows of the card. The gauze styles illustrated in Fig. 295 will be produced the other way up in top douping by cutting the blanks and dots on the middle eight rows of the card, and the dots on the first and tenth row.

D in Fig. 302 represents a top doup gauze effect, which corresponds with the structure given at C in Fig. 295. The plan E shows how the weave is indicated if weft is painted, and F if warp is painted. G and H in Fig. 302A respectively show the weft and warp methods of designing a figure, from which it will be seen that in this case fewer marks are required in painting for weft, which is, therefore, the more convenient method. The example is similar to that given in Fig. 299, with which comparisons may be made. The figure is in weft float, and the card-cutting particulars for G are cut blanks and dots, and for H cut marks (except the shaded squares) on the middle eight rows of the card; the dots are cut on the first and tenth rows in both cases.

The special gauze harness is not limited to effects in which two cross two. Other arrangements can be woven by casting out the harness in long rows. For example, one-crossing-one styles can be produced by casting out one-half, and one-crossing-two effects by casting out one-quarter of the figuring harness rows, while by casting out one-half of the doup harness and easing mails two-crossing-six effects can be woven.

MADRAS GAUZE FABRICS

Structure of the Cloth.—In the Madras muslin texture a gauze foundation, which is formed continuously throughout the cloth, is ornamented with extra weft. Fig. 303 shows the appearance of a typical fabric, as viewed from opposite sides, while the diagram No. 1 in Fig. 304 illustrates the interlacing of the threads. The warp consists of crossing ends and standard ends arranged one-crossing-one, and in the gauze structure, which is very light and open, there is one ground pick in each shed. The extra weft is softer spun and usually much thicker than the ground weft; it is interwoven with the warp where required, and floats loosely in the remaining parts of the design. The loose floats are afterwards cut away, and a texture with an opaque figure on a transparent gauze ground, or *vice versa*,

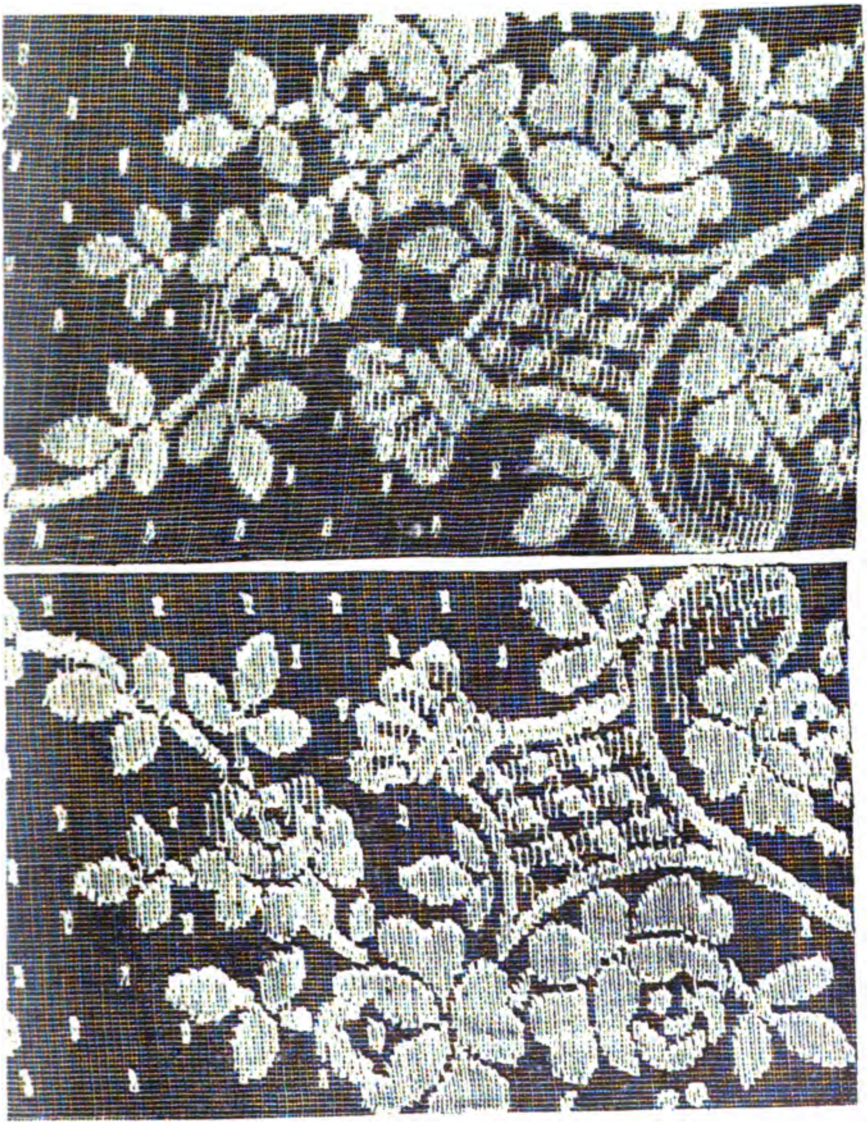

Fig. 303.

results, which is particularly serviceable for use as window curtains. The appearance of the cloth after the cutting operation is represented in Fig. 303, which shows, on the left, the fabric as viewed from the cut side—that is, the side on which the extra picks float loosely during the weaving of the cloth, and on the right, as viewed from the uncut side. Most frequently the cloths are woven with the cut side uppermost, but they are produced to a considerable extent in the reverse way. The latter method, however, causes the jacquard lift to be very heavy. When used as window curtains, either side of the cloth may be taken as the right side, but, as shown in Fig. 303, the ornament has a bolder outline on the cut than on the uncut surface, hence for certain purposes the cut side is taken as the right side. The uncut surface, however, is neater, and for such cloths as dress fabrics, for which the structure is to some extent adapted, this is mostly taken as the right side.

The Madras Loom.—Special types of looms have been built for weaving the cloth. The following illustrations and description correspond with one of the

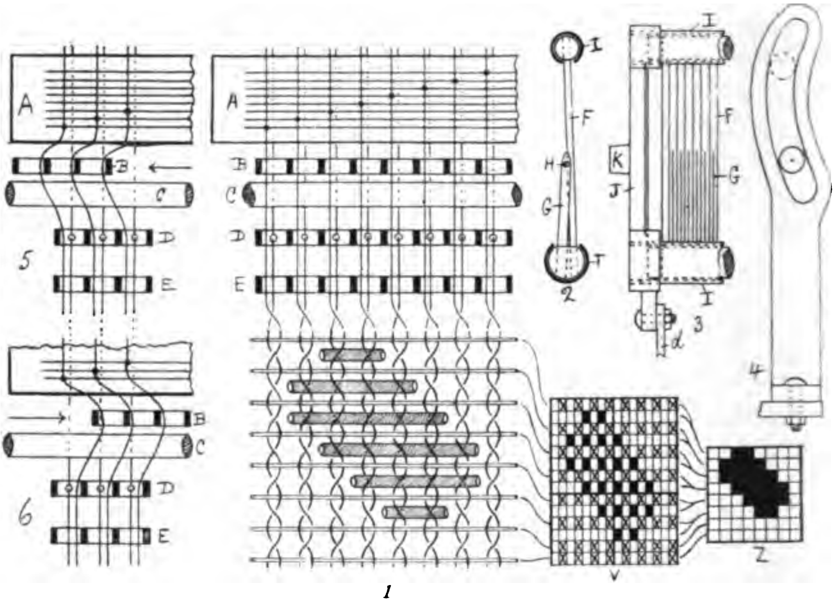

Fig. 304.

most recent systems, and, although the motion dealt with may differ in details from others that are in regular use, the principles are the same in every case. In the diagram No. 1 in Fig. 304 the structure is represented from the same side as the cloth on the left of Fig. 303, *i.e.*, as viewed from the cut side. When the texture is woven with this side uppermost the crossing ends are raised and the standard ends are left down on every ground pick. On the figuring picks all the crossing ends are left down, but the standard ends are raised where the extra weft has to be interwoven, and the latter is, therefore, firmly bound in between the standard and crossing ends. The plan given at Y corresponds with the effect shown in the diagram No. 1; the full squares indicate the lifts of the standard ends and the crosses of the crossing ends. The crossing ends, however, are operated independently of the jacquard harness, while no standard ends are raised on the ground picks; therefore in constructing a card-cutting plan it is only necessary to indicate the lifts of the standard ends on the figuring picks, as shown at Z, which illustrates the usual method of designing a figure.

System of Drafting.—An ordinary form of double-lift jacquard and harness is generally employed, but in front of the harness A there are, in the following order, a tug reed B, an easing bar C, a gauze reed D, and an ordinary weaving reed E. These are represented in the diagrams given in Figs. 304 and 305, while the draft of the ends is indicated in the upper portion of No. 1 in Fig. 304. The standard ends are drawn through the harness mails, and then are passed through the reed B, above the bar C, and through the reeds D and E. The crossing ends are passed between the harness cords, under the tug reed B and the bar C, then through eyes in short wires in the gauze reed D, and afterwards each end is passed along with its accompanying standard end through a split in the weaving reed E.

Method of Crossing the Ends.—The crossing of the ends is effected by means of the tug reed B and the gauze reed D. The tug reed is about 5 inches deep on the wires and is of ordinary form, except that each end piece is about 1 inch wide and is provided with a hole to which a chain connection is made, as shown in Fig. 306. This reed is suspended by wires in front of the harness, and by means of the chain connections it is moved about $\frac{3}{4}$ inch to left and to right on succeeding ground picks. The form of the gauze reed is shown separately in the diagrams 2 and 3 in Fig. 304. Between each pair of long wires F there is a short, pointed wire G which is slightly inclined, and is provided near the top with an eye H through which a crossing end is drawn. The baulks of the reed are slided within close-fitting metal cases I, and at each side the latter are secured by pins inside holes bored in a metal end piece J. The arrangement of the parts makes the reed very strong and rigid. Each end piece J is provided with a stud K, which fits within a curved slot formed in a guide, as shown in diagram 4 in Fig. 304. The gauze reed is raised and lowered on each ground pick, during which the studs K slide within the curved slots so that the movement is slightly circular. When the reed is down the points of the short wires G are below the lower line of the shed, as shown in diagram No. 7 in Fig. 305. When it is raised all the crossing ends are lifted sufficiently high to form a shed for the shuttle to pass through in front of the weaving reed E, as shown in No. 8. Each time the gauze reed is lowered the tug reed is moved laterally, and the standard ends, which pass through the latter reed, are pressed by the wires and traversed to left or to right. This is illustrated in the diagrams 5 and 6 in Fig. 304, in which small circles represent where the crossing ends pass through eyes in the short wires of the gauze reed. Diagram 5 shows the tug reed moved to the left and diagram 6 to the right, so that each standard end is moved above the point of a short wire of the gauze reed from one side to the other. Hence on succeeding ground picks, as the gauze reed rises it lifts the crossing ends first on the right and then on the left of the standard ends, in which positions they are bound in by the ground weft. The movement illustrated in the diagram 5, will take place previous to the insertion of the odd ground picks of the structure represented in diagram 1, and in the diagram 6, previous to the insertion of the even ground picks.

Method of Easing.—The easing bar C, to which the term dipping tube is applied, has an important function, as will be seen from a comparison of its position in the diagrams 7 and 8 in Fig. 305. The bar rises and falls on each ground pick in coincidence with the movement of the gauze reed, and maintains a uniform tension on the crossing ends.

Arrangement of Shuttle Boxes.—The Madras loom is made with four boxes at each side (sometimes only two are employed), but the two series of boxes are connected so that they rise and fall together. Not more than three figuring shuttles, as well as the ground shuttle, can, therefore, be employed at the same time, but in different parts of a design it is possible to employ the ground shuttle only or to insert one, two, or three extra picks to each ground pick according to requirements. The box motion is governed by the jacquard cards through four needles and hooks that are set aside for the purpose. The position of each box is directly controlled by the allotted needle and hook, but the lift for a given box is cut on the card for the pick preceding that for which the box is required. Thus, assuming that three figuring wefts are inserted to each ground pick, and the boxes are operated in the order of 2, 1, 3, 4, a hole will be cut to operate No. 1 box on the first of each four cards, No. 3 box on the second, No. 4 box on the third, and No. 2 box on the fourth. The ground weft shuttle is placed in the fourth or bottom box. The figuring wefts may be inserted in almost any sequence, but one figuring colour—usually that which is inserted most frequently and most regularly throughout the design—is taken as the leading colour, and is placed in the third box (the next box to the ground shuttle). An important feature is that when the gauze ground shuttle (the bottom box) is brought into operation the special motions of the loom are automatically put into action.

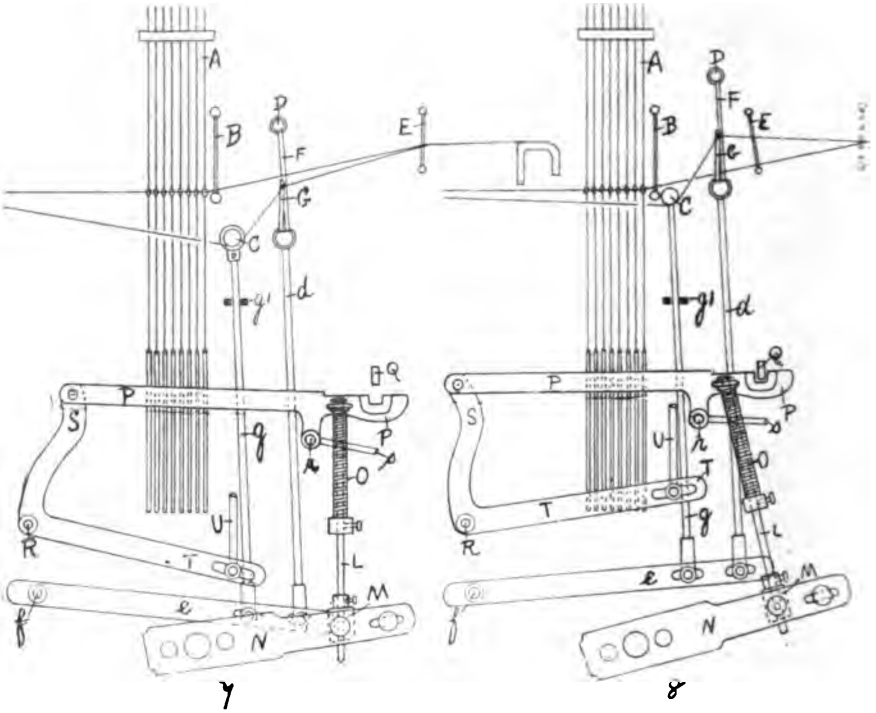

Fig. 305.

Operation of the Gauge Reed.—The rising and falling motion of the gauze reed on each ground pick is imparted by the backward and forward movement of the slay. The position of the parts, at the extremities of the movement, is represented in the diagrams 7 and 8 in Fig. 305. The lower end of a rod L passes loosely through a slot in a bracket M which is bolted to the inner side of the box lever N, while the upper end passes loosely through the slot of a projection that is connected to a horizontal lever P. Two collars are set-screwed on the rod L, the lower one of which, according to the position of the box lever N, is either just above or rests on the bracket M, while the higher one retains a spring O with its upper end against the underside of the projection on the lever P. The parts are also shown

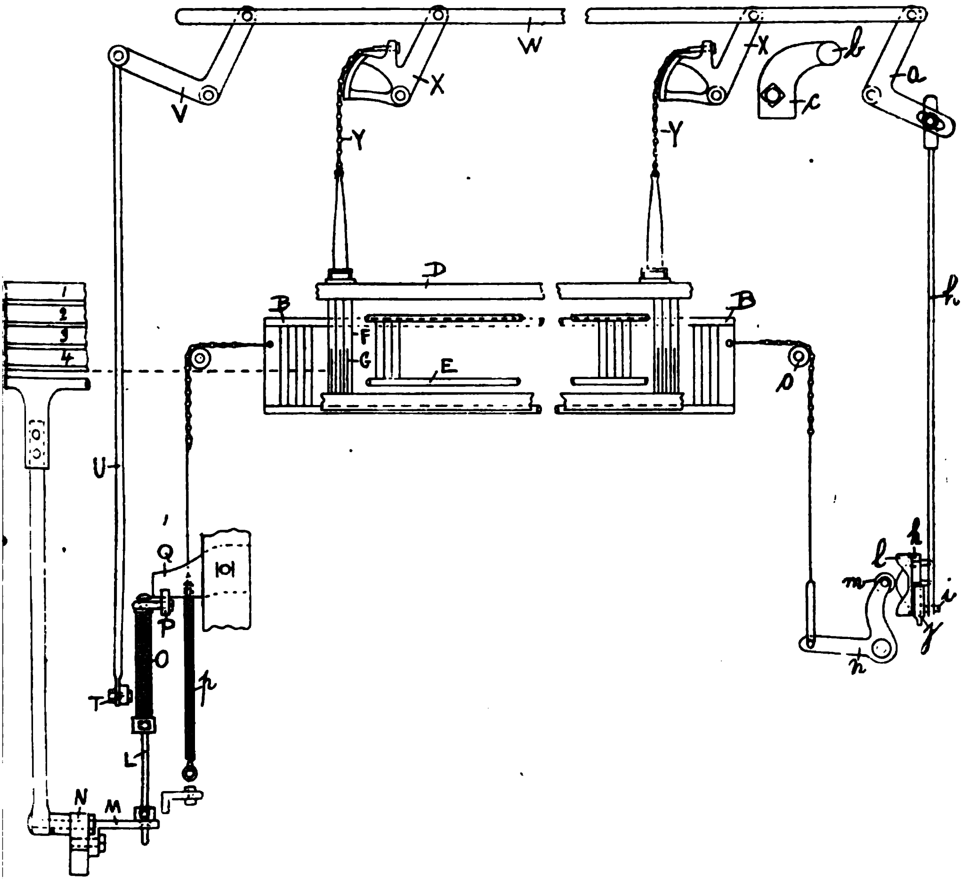

Fig. 306.

in the front elevation given in Fig. 306. When the boxes are raised to their highest position (as shown on the left of Fig. 306) so that the bottom box—which contains the ground weft shuttle—is brought into line with the race board, the upward movement of the box lever N lifts the rod L just high enough to cause the pressure of the spring O to raise the lever P at its forward extremity. This takes place at the time of beating up, when a bar Q, which is bolted to the back of a sword, is immediately above a recess formed in the upper side of the lever P, as shown in diagram 7, Fig. 305. The lever P, when raised, is brought into engagement with the bar Q, as shown in diagram 8, and as the latter moves backward and forward with the sword, a similar movement is imparted to the lever P. A bell-crank lever, which is fulcrumed on a stud R, has its upper arm S pivotally connected to the rear of the lever P, hence the movement of the latter causes the forward end of the lower arm T to rise and fall. This movement, by means of a rod U, is imparted to the lower arm of a bell-crank lever V (shown in Fig. 306), the upper arm of which transmits a motion—to right and to left alternately—to a horizontal bar W. The lateral movement of the bar W, through the segment levers X, and the chain connections Y, causes the gauze reed to rise and fall; and this takes place with each backward and forward movement of the sword so long as the gauze ground weft only is inserted. On the insertion of a figuring pick, however, the the lowering of the box lever N releases the pressure of the spring O against the projection on the lever P, the forward end of which then falls out of engagement with the bar Q, as shown in the diagram 7. The gauze reed then remains in its lowered position while the required number of figuring picks is inserted. The distance that the gauze reed rises and falls can be adjusted by altering the leverage; it is prevented from falling too far by the upper arm of a bell-crank lever *a*, Fig. 306, coming in contact with a stud *b* carried by an adjustable bracket *c*. The latter is set so as to allow the horizontal bar *w* to move the necessary distance before it is checked.

Operation of the Easing Bar.—A connection is made from each end piece of the gauze reed by means of a rod *d* to a lever *e* which is fulcrumed on a stud *f*, as shown in the diagrams 7 and 8 in Fig. 305. A rod *g*, which passes between the forks of a guide g^1, connects each lever *e* with an end of the easing bar C. The latter, therefore, through the levers *e*, receives a rising and falling motion which coincide with the movement of the gauze reed. Slots are provided in the levers *e* in order that the extent of the movement may be regulated.

Operation of the Tug Reed.—The lateral movement of the tug reed is obtained from the same source as the vertical movement of the gauze reed. The lower arm of the bell-crank lever *a* (shown on the right of Fig. 306) is connected by means of a rod *h*, with a stud *i*, on which a catch *j* is fulcrumed. The catch *j* engages the teeth of a six-sided star wheel *k* on the face of which there is a cam *l* that has three projections and three recesses arranged alternately. The cam *l* engages an anti-friction bowl *m* which is carried by the upper arm of a lever *n*, the lower arm of which, through a chain passing over a guide pulley *o*, is connected with one end of the tug reed B. At the opposite side of the tug reed a similar connection is made to a spiral spring *p*, the tension of which retains the bowl *m* in constant contact with the face of the cam *l*. At each downward movement of the gauze reed (which follows the insertion of a ground pick) the lower arm of the lever *a* is raised and the catch *j* turns the star wheel *k* one-sixth of a revolution. At one movement the anti-friction bowl *m* is engaged by a projection on the cam *l* so that it is pressed back, as shown in Fig. 306, the tug reed being thus drawn to the right against the tension of the spring *p*. At the next movement the bowl *m* enters a recess in the cam *l* when the tension of the spring *p* causes the tug reed to move to the left. The direction of the movement is the same as that of the preceding ground pick. (In an older motion, in place of the tug reed, a horizontal reed or ravel is employed, and between each pair of wires a short row of harness cords is passed. The comber-board is placed well above the ravel, and the latter is given a latitudinal movement which moves the harness cords and causes the standard ends to be traversed from one side to the other, above the points of the wires of the gauze reed.)

The Picking Motion.—The direction of the pick is governed from the same source as the movement of the gauze reed. The cam *l*, Fig. 306, acts upon a second anti-friction bowl—similar to the bowl *m*—which is carried by a lever that is fulcrumed on the same stud as the lever *n*. The two bowls are on opposite sides of the cam *l*, so that when one bowl is engaged by a projection the other is within a recess. A change in the direction of the pick is, therefore, made at the same time as the tug reed is moved, and this always takes place after the insertion of a ground pick, and while the gauze reed is being lowered. When the anti-friction bowl, which governs the direction of the pick, is within a recess of the cam *l*, the picking mechanism on the right is brought into position for being operated, while that on the left is put out of action. As many figuring picks as are required, and the following ground pick, are then inserted from the right, after which the cam *l* is turned, which causes the picking mechanism on the left to be put into action and that on the right to be made inoperative. The order of picking is limited to a certain extent by the arrangement because a figuring pick from one side of the loom must be followed by a ground pick from the same side before the direction of the pick can be changed. The limitation, however, is not of great importance in weaving the fabrics for which the loom is intended. In indicating a design in which a figuring weft is introduced intermittently, it is only necessary to leave an even number of horizontal spaces between two succeeding portions of the figure produced by that weft in order to ensure that the direction of the pick will coincide with the position of the shuttle. (In a very recent device the direction of the pick is governed by the action of the shuttle box swell, and the limitation, mentioned in the foregoing, is done away with. At the side of the loom on which a shuttle is in line with the race, the pressing back of the swell, by suitable connections, causes the picking mechanism at the opposite side to be made inoperative, while the absence of a shuttle at one side brings into action the picking mechanism at the other side. In the event of anything occurring to bring a shuttle at each side in line with the race, the picking mechanism at both sides of the loom is put out of action.)

The Up-take Motion.—In different parts of a design the number of extra picks to each ground pick may vary from none to three, but it is very necessary for the foundation texture to be uniform. For this reason the up-take motion is operated from the lever P so that the cloth is drawn forward only when a ground pick is inserted. A projection on the lower side of the lever P (see Fig. 305) carries a stud *r* which is connected by a rod *s* to the lever that operates the take-up pawl. Each time the lever P is drawn forward the ratchet wheel of the up-take motion is turned one tooth. The arrangement ensures that the same number of ground picks per inch will be put in however irregularly the figuring weft is inserted.

Madras Designing.—Very little variation can be made in the Madras structure on account of the special means employed in weaving the cloth, and because the shearing operation makes it necessary to avoid the formation of long figuring floats on the cut side of the texture. As viewed from the uncut side, all the crossing ends (which are operated simultaneously by the gauze reed) are above the figuring picks, so that on this side the floats cannot be longer than the space between two consecutive crossing ends. On the cut side the standard ends are above the figuring picks where the latter are interwoven, and so far as the weaving of the cloth is concerned these ends may be operated by the harness as desired. It is, however, generally recognised that in the figure the weft should pass over not more than one standard end at a place, otherwise the floats are liable to be cut away in the shearing process. Only the very simplest weave development is, therefore, possible, and the ornamentation of the texture is chiefly dependent upon the formation of different degrees of density, and upon colour. The cloth is largely made all white or cream, only one extra weft being employed; but a considerable trade is also done in fabrics in which two or three different figuring wefts are introduced on a white or coloured foundation. A large number of ends per inch cannot be employed because the fineness of the gauze reed is limited, and the setts usually vary from 32 to 50 ends per inch, the latter number being seldom exceeded. The ground picks range from 24 to 36 per inch, but the total picks vary according to the proportion of extra picks to each ground pick, and whether the extra weft is introduced regularly or intermittently. The ground yarns are mostly of very good quality and fine in counts—ranging from 60's to 90's cotton—while the soft spun figuring weft varies from 10's to 18's cotton. The following are typical weaving particulars:—Warp, 80's cotton, 44 ends per inch; figuring weft, 12's cotton; ground weft, 70's cotton: 30 ground picks per inch.

Modifications of the Madras Structure.—The most common modifications of the Madras structure, as viewed from the cut side of the cloth, are illustrated at A, E, H, L, O, and R in Figs. 307 and 308, in which the crossing ends are those which are over all the ground picks. The corresponding condensed plans on the right of the examples show how the effects are indicated on design paper for the card-cutting, while on the left the complete plans are given, the crosses in which represent the lifts of the crossing ends by the gauze reed, and the full squares and dots the lifts of the standard ends by the harness. A in Fig. 307 shows the ordinary opaque structure, and a modification in which only the alternate figuring picks are interwoven. The latter produces a semi-opaque effect which forms a pleasing contrast between the transparent ground and the opaque portions of a design, and may be used effectively in shading a figure. The marks in the plan B indicate where the standard ends are raised on the figuring picks when the cloth is woven with the cut side up. The appearance of A when turned over from left to right is represented at D; the texture is the same on both sides, except that the free ends of the figuring picks show more prominently on the cut side. In D the crossing ends are under all the ground picks.

E in Fig. 307 illustrates another method of producing different degrees of density. In this case two figuring picks of different thicknesses are inserted to each ground pick; both wefts are interwoven in forming the opaque structure but in the semi-opaque effect only the finer weft is interwoven. Two figuring cards are cut from each horizontal space of the condensed plan F, the full squares and dots being cut on the first card, and the full squares only on the second.

In the modification shown at H in Fig. 307 the density is the same as in the ordinary structure, but the figuring weft is brought more prominently to the surface on the cut side of the cloth. The standard ends are raised alternately on the figuring picks, as shown by the plain order of marks in the plan I. On the uncut side, a view of which is given at K, the figuring weft shows less prominently than in the ordinary structure.

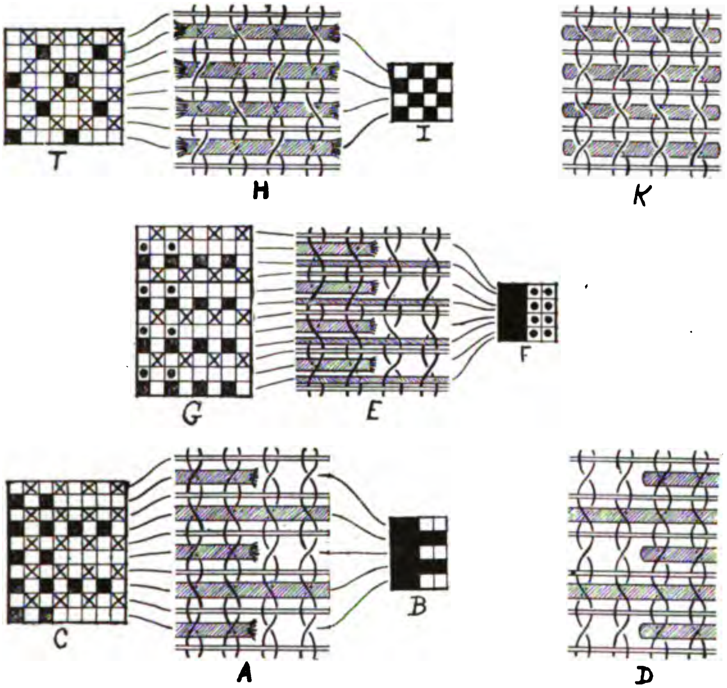

Fig. 307.

The alternate system of operating the standard ends can be effectively employed in mixing two different colours of weft in the manner represented at L in Fig. 308.

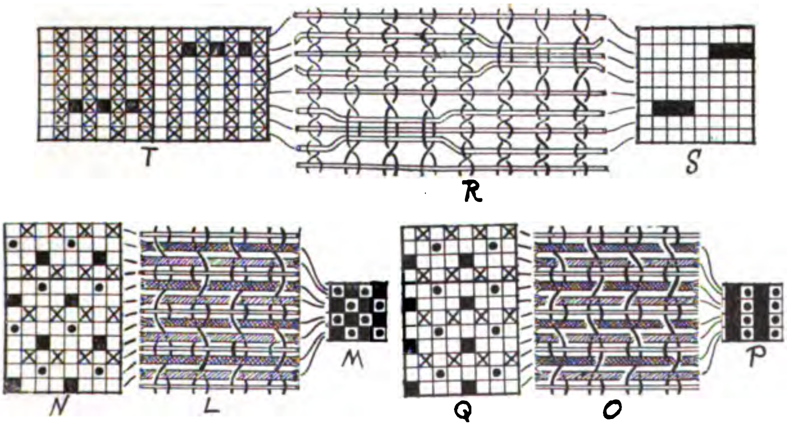

Fig. 308.

Each horizontal space of the plan M represents two figuring cards, in one of which the full squares are cut, and in the other the dots. The mixed colour effect may be used as a subsidiary to the patterns formed separately by the two colours of weft, from which it also differs in density.

O in Fig. 308 shows another method of mixing two colours, in which each weft is bound in a straight line by the alternate ends, so that vertical lines of colour are formed. The card-cutting particulars for the plan P are the same as for M.

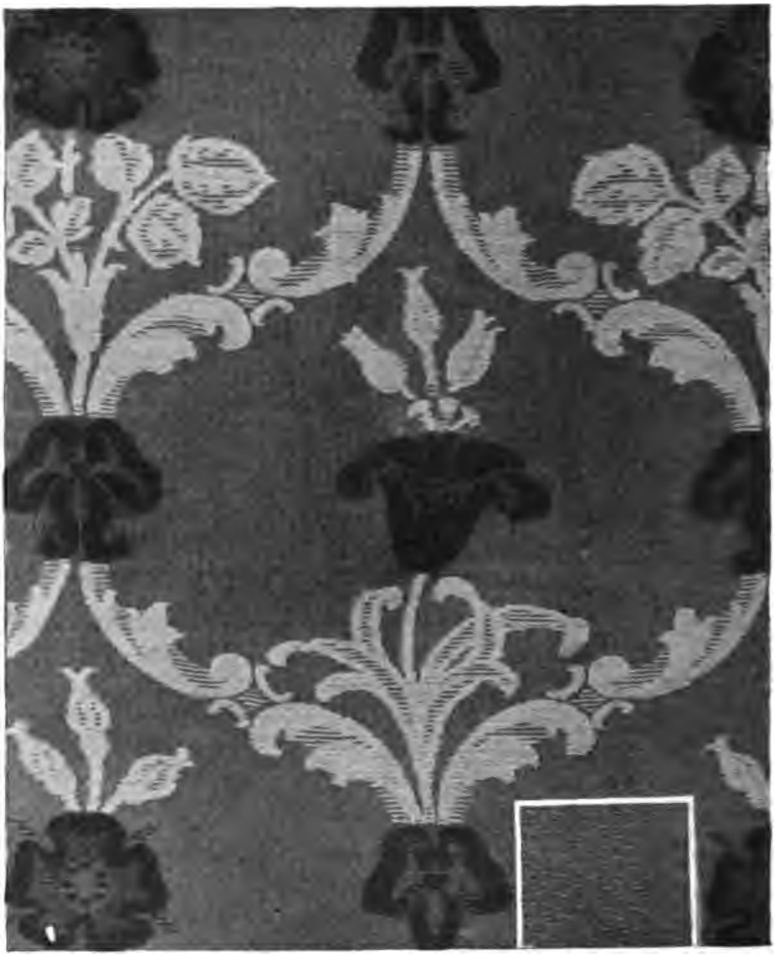

Fig. 309.

It will be understood that the small floats, shown in H, L, and O, remain in the cloth as they are too short to be cut away by the shears; the latter are set close enough to engage any floats that are longer than those shown in the examples.

The diagram given at R in Fig. 308 shows how the gauze ground structure may be modified by lifting certain standard ends at the same time as the crossing ends are raised by the gauze reed. This prevents a crossing taking place so that at these places the ends lie straight for three picks which are grouped together. The marks in the plan S, which show where the standard ends are raised on the ground picks, will be cut on the ground cards, and in this respect the example is different from the foregoing styles. In weaving the ordinary gauze foundation, all the ends required up are raised by the gauze reed, so that the cards for the ground picks are blank except where holes are cut for the purpose of operating the boxes and the selvages. As regards the figuring picks, sometimes these are not interwoven with the selvages, catch ends being provided for them at each side, so that on the figuring cards, in addition to cutting the marks of the design, it is necessary to cut holes to correspond with the lifts of the selvages or the catch ends, as well as holes for operating the boxes.

Single Cover Chintzed Design.—An illustration is given in Fig. 309 of a Madras muslin texture which is termed a "single cover," that is, there is only one figuring pick to each ground pick. Three different figuring wefts —white, green, and pink— are, however, employed, but these are chintzed, one following another in succeeding sections of the design. The ground is transparent, and in the figure, in addition to the ordinary opaque structure, effects are formed which correspond with those represented at A and H in Fig. 307. Also, for the purpose of illustration, in the lower portion of Fig. 309 a sample of a gauze ground texture is inset which is similar to the example given at R in Fig. 308. A section of the design, which corresponds with the lower central portion of Fig. 309, is indicated on design paper in Fig. 310, the different marks representing different colours of weft. Where the ordinary opaque structure is formed the figure is simply painted in solid, but in producing the semi-opaque effect the alternate horizontal spaces only are filled, in while in bringing the weft more prominently on to the cut side a plain order of marking is employed. It is important to note that if the transparent gauze ground is required to show distinctly between two detached portions of figure formed by the same weft, the two portions must be separated horizontally by at least two blank spaces of the design paper. Otherwise the weft floats between the parts of the figure will not be long enough to be engaged by the shears, and the two portions of figure will appear to join up.

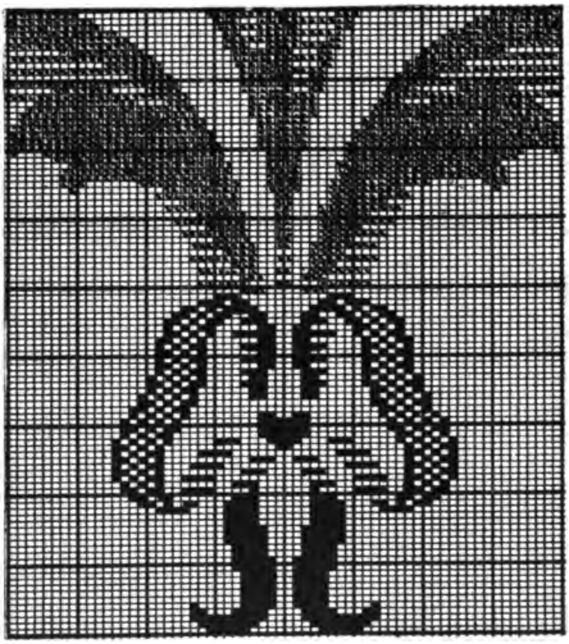

Fig. 310.

Gauze Figure on Opaque Ground.—Fig. 311 shows a Madras style in which a transparent and semi-transparent figure is formed on an opaque ground. A corresponding portion of the design is given in Fig. 312, the method of designing being the same as in the last example except that the form of the figure is represented by the blanks. A special feature in this case is the formation of a geometrical pattern on the opaque texture by floating the figuring weft over one standard end at a place on the cut side of the cloth. These floats are too small to be affected by the shearing operation, and although the pattern is almost invisible on the uncut side of the texture, on the reverse side it is sufficiently prominent to relieve the stiffness of the opaque ground.

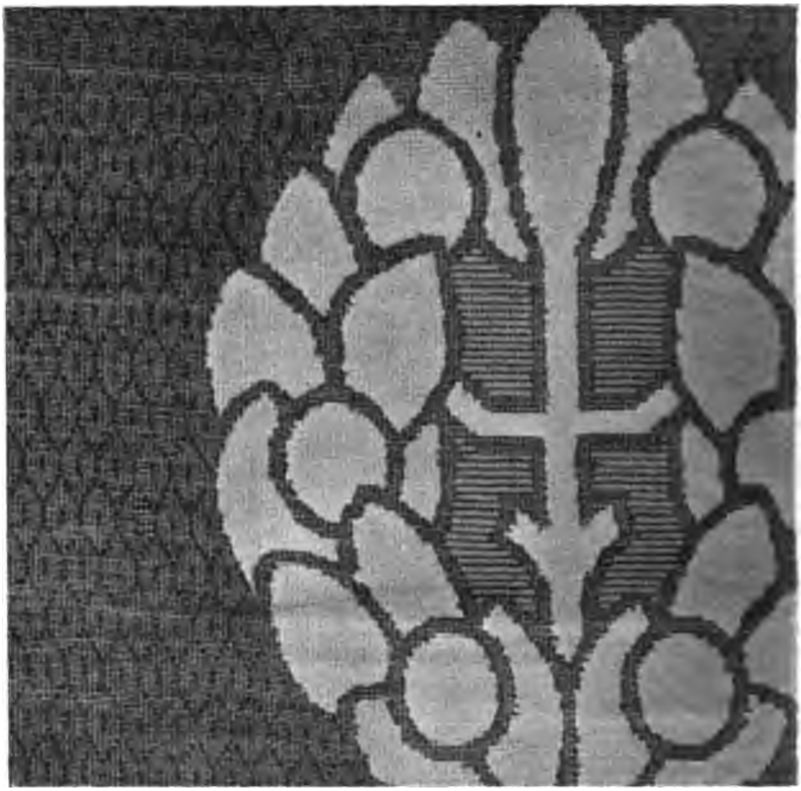

Fig. 311.

Complex Three-colour Fabric.—A more complex structure is illustrated in Fig. 313, and in the corresponding sectional plan given in Fig. 314. In this case three different kinds of figuring weft are employed, but not more than two are introduced at the same time, and in some places only one. Seven different effects, which are represented by the different marks in Fig. 314, are, however, formed. In Section A the weft is white and blue, in Section B white only, and in Section C white and heliotrope. The white weft is introduced continuously and is, therefore, taken as the leading colour, and placed in the box next to the ground shuttle. The full squares, dots, and crosses in Fig. 314 respectively represent the white, blue, and heliotrope, where each forms a separate effect. The white and blue wefts are mixed (in the manner illustrated at L in Fig. 308) where the full squares and dots alternate in plain order, and the white and heliotrope are similarly mixed where the full squares and crosses alternate. A dividing line is formed round each mixed effect by interweaving two wefts together, the circles showing where the white and blue are interwoven together, and the vertical strokes the white and heliotrope.

System of Card-cutting.—Each horizontal space of the design represents as many figuring cards as there are colours of weft inserted to each ground pick, and the following ground card. The pattern formed by the leading colour of weft is cut on the card which precedes the card for the ground pick. The full card-cutting particulars for the design given in Fig. 314, are indicated in the accompanying list (except that the lifts for the selvages are omitted), assuming that the ground, white, blue, and heliotrope wefts are respectively placed in the boxes Nos. 4, 3, 2, and 1.

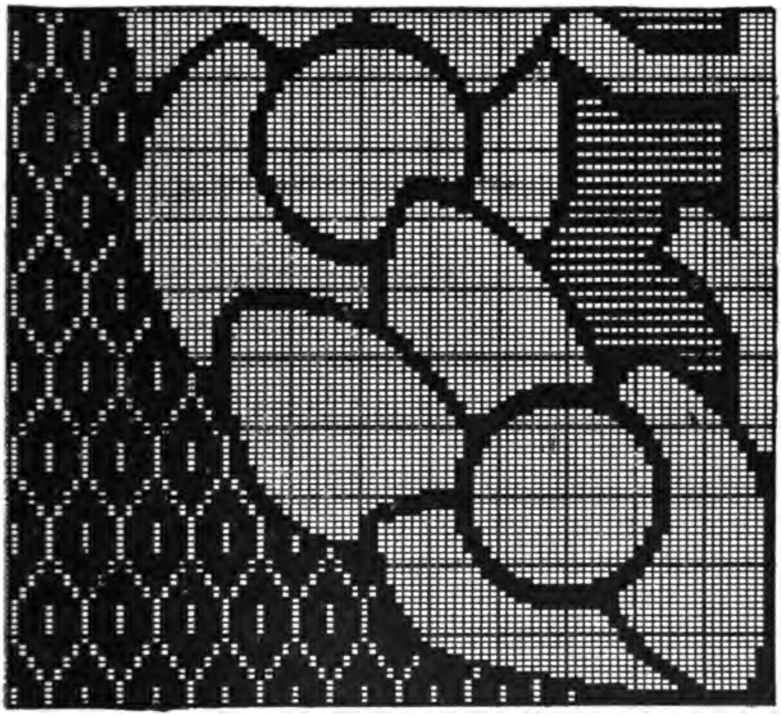

Fig. 312.

Section A.—First card (blue weft in No. 2 box), cut the dots and circles and the lift for No. 3 box; second card (white weft in No. 3 box), cut the full squares and circles and the lift for No. 4 box; third card (ground weft in No. 4 box), cut the lift for No. 2 box.

Section B.—First card (white weft in No. 3 box), cut the full squares and the lift for No. 4 box; second card (ground weft in No. 4 box), cut the lift for No. 3 box.

Section C.—First card (heliotrope weft in No. 1 box), cut the crosses and vertical strokes and the lift for No. 3 box; second card (white weft in No. 3 box), cut the full squares and vertical strokes and the lift for No. 4 box; third card (ground weft in No. 4 box), cut the lift for No. 1 box.

In each section the cutting is repeated for the required number of times, but on the last ground card in Section A the lift for No. 3 box is cut, and in the last card in Section B the lift for No. 1 box, etc.

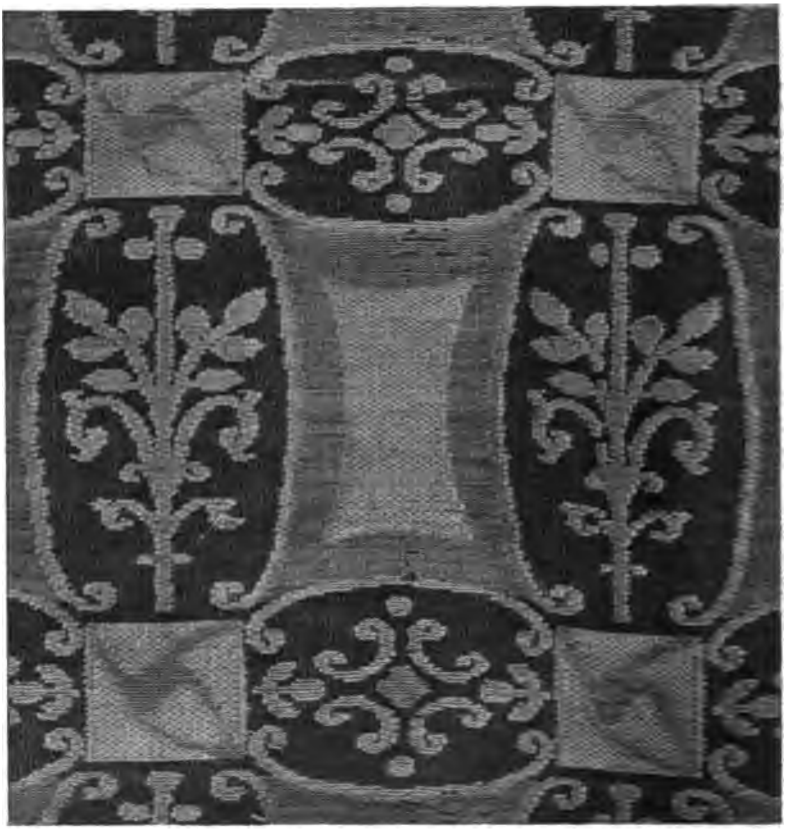

Fig. 313.

As only half the ends are operated by the jacquard harness a large repeat can be obtained from a comparatively small tie. Thus, in a cloth with 44 ends per inch, a 400 tie will give a repeat in width of 400 $\div {}^{44}/_{2} = 18$ inches. The counts of the design paper is in the proportion of the harness ends per inch to the ground picks per inch. For example, if there are 44 ends and 30 ground picks per inch, the proportion is—$(44 \div 2) : 30$, or 8×11 design paper.

The proportion of the " cover " is found in the same manner as in book-harness muslins (see p. 174), but in a Madras design in which more than one colour is inserted to a ground pick, it is necessary to count the colours separately on each horizontal space. Thus the last example is a " double-cover " except in the parts (lettered B in Fig. 314) where only one figuring weft is inserted.

In a recent development of the Madras structure the cloth is made perfectly reversible with the figure in different colours on opposite sides. Two figuring picks in different colours are inserted to each ground pick, on one of which alternate standard ends are raised by the harness in the ordinary manner where the figure is required to be formed. On the other pick all the ends are raised except alternate standard ends in the figure, which is accomplished by lifting the gauze reed, all the standard ends in the ground, and alternate standard ends in the figure. Loose

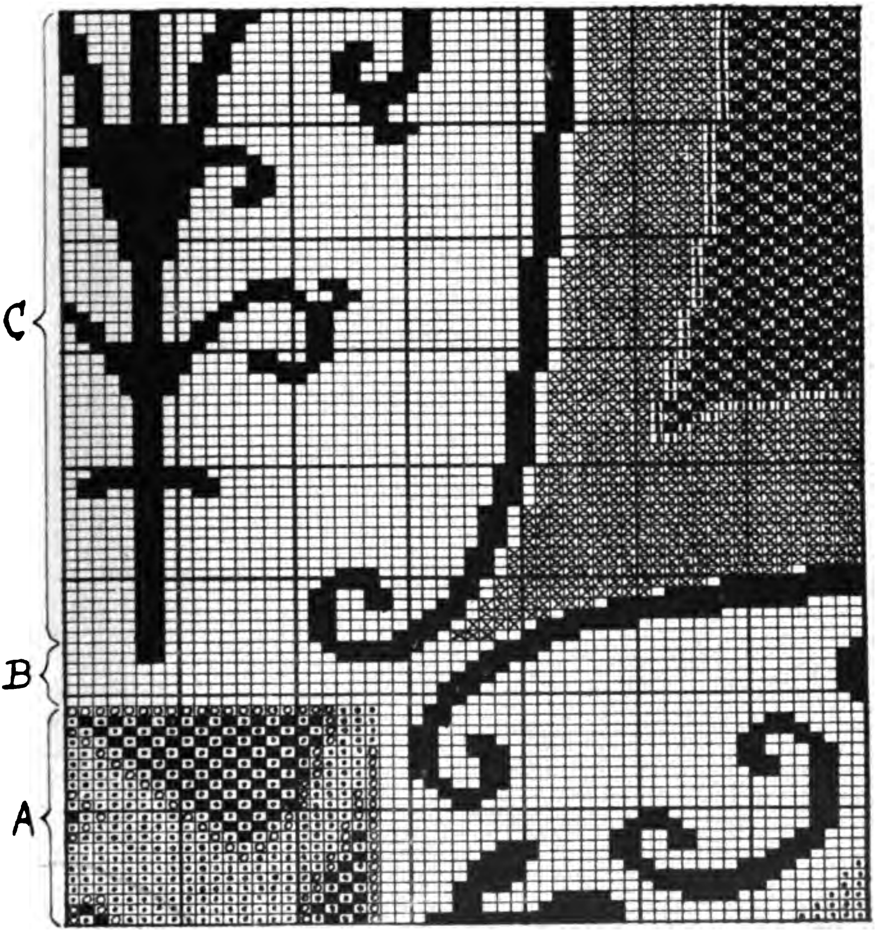

Fig. 314.

floats of weft extend between the parts of the figure on both sides of the cloth, so that a double cropping operation is required. One figuring weft shows prominently on one side, and the other on the other side, because each passes over the alternate standard ends and all the gauze ends on the side on which it forms the figure.

CHAPTER XIV

LAPPET WEAVING AND DESIGNING

Features of Lappet Figuring—Scotch Lappet Wheel Loom. *Common Wheel Lappet System*—Rotation of the Pattern Wheel—Vertical Movement of the Pin and Needle Bars—Method of making the Needle Bars Inoperative—Lateral Movement of the Needle Bars—Relation of Movement of Shifter Frames to Rotation of Pattern Wheel—Construction of a "Common" Lappet Wheel—Methods of Indicating Lappet Designs—Method of Indicating a Pattern Groove. Continuous Two-frame Lappet Design—Relative Positions of the Needle Bars and Pecks. Intermittent Three-frame Lappet Style—Continuous All-over Three-frame Lappet Design. Crossing the Needle Bars. To find the Diameter of a Wheel—The Length of Repeat. Methods of Diversifying Lappet Designs—Spacing the Needles in the Bars. *Presser Wheel System*—Construction of a Presser Wheel—To find the Length of Whip Warp—Lappet Styles in Imitation of Net Leno—Waved Russian Cords. Imitation Lace. Patterns produced by varying the Order of Lifting the Needle Bars.

Features of Lappet Figuring.—In this system of weaving, the special features of which are illustrated in Fig. 315, figuring or "whip" threads are introduced as extra warp on a foundation fabric. In forming the figure these longitudinal threads are traversed in a horizontal direction on the face side of the cloth, and are bound to the latter by a weft pick at the extremity of each traverse. On account of the manner in which the horizontal movement is imparted to the whip threads, it is impossible for the floats to be stitched to the ground texture except at each extremity; therefore a figure, or a part of a figure, formed by one thread cannot be submitted to any form of interlacing. Any kind of ground weave may be employed but as the foundation requires to be very firm, in order that the ground ends will not be unduly disturbed by the side pull of the whip threads, plain or gauze ground is usually employed. One repeat of the pattern is limited to from one to usually not more than four different orders of working, while compared with jacquard figuring the number of picks in the

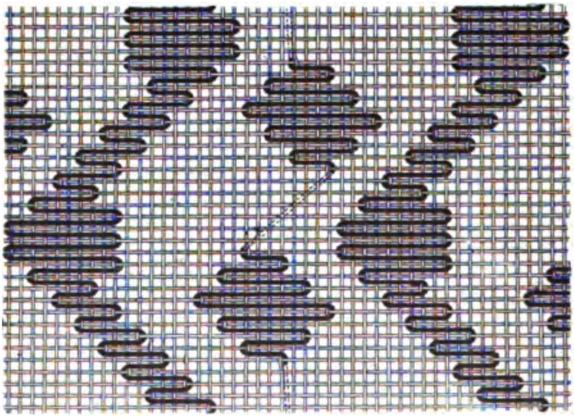

Fig. 315.

repeat is also restricted. The mechanisms employed, and their adjustment, are of a nature that renders it almost impossible for such accuracy to be obtained as will ensure that succeeding repeats of a design are exactly the same, and the outline of a figure has a somewhat steppy appearance. In spite, however, of the many limitations thus imposed upon lappet ornamentation, by skilful arrangement great diversity of design can be produced.

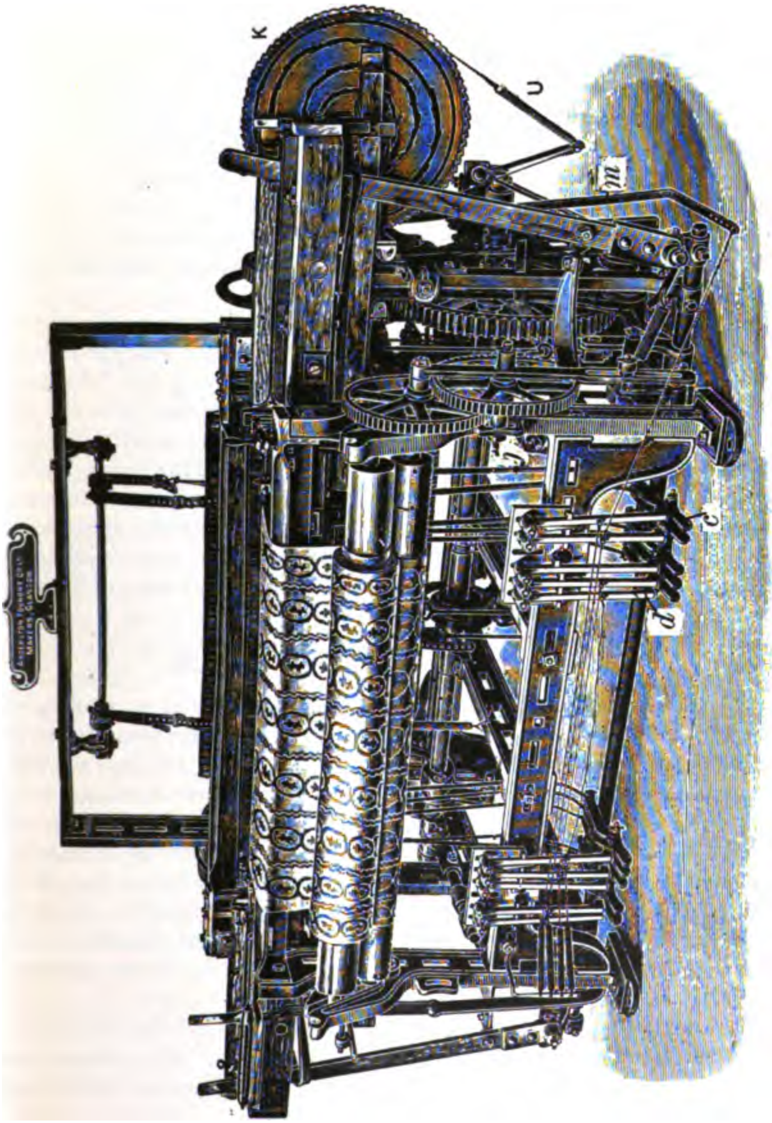

Fig. 316.

In order that the principles of designing for the styles may be thoroughly understood, some knowledge of the means by which the whip threads are operated is necessary. The features which have to be regarded by the designer, however, vary somewhat according to the class of lappet mechanism which is employed. The Scotch lappet wheel system is most commonly used, and this type of loom, and the styles produced upon it are, therefore, described and illustrated. Many of the parts of this motion are common to all lappet mechanisms, the differences between which are chiefly due to the method in which the horizontal movements are imparted to the whip threads.

Scotch Lappet Wheel Loom.—Fig. 316 gives a general view of a four-frame left-hand lappet wheel loom (as constructed by the Anderston Foundry Company, Limited, Glasgow), in which some of the parts are lettered to correspond with the drawings in Figs. 317 and 318 in order that their position and method of operation may be compared. Various parts of the mechanism are represented in side elevation in Fig. 317; also in front elevation in the upper portion of Fig. 317, and in plan in the lower portion. The parts are to scale, except that certain features are accentuated, and while the description is of a four-frame loom the duplication of the mechanism, in all cases, is not shown.

The lappet wheel system has obtained its name from the use of a wheel K as the means of governing the horizontal movements of the whip threads in forming the pattern. There are two kinds of these pattern wheels—viz., (1) A " common " wheel used for styles in which the whip threads are moved alternately to the left and to the right on succeeding picks, and produce figures which are more or less massive. (2) A " presser " wheel which is employed when in some part of a design a whip thread is required to move in the same direction on succeeding picks—as, for example, in forming a fine line of figure running more or less in a diagonal direction across the cloth. The latter is less extensively employed than the former, and as its use necessitates certain modifications of the loom to be made, the ordinary or " common " wheel lappet system will be considered first.

" COMMON " WHEEL LAPPET SYSTEM

Fig. 315 illustrates the style of lappet design produced by a common wheel. The figure, which is represented as being formed upon a plain foundation, results from the combination of two orders of working, one of which produces a continuous waved line effect, and the other a spot effect. The manner in which the whip threads are stitched in by the picks, and exert a side pull on the ground ends, is indicated, and it will be noted that in plain ground the effective distance traversed by a whip thread is always equal to the space occupied by an even number of ground ends. A traverse of an odd number, in plain ground, is impossible, as in such a case the interlacing of the ground ends will permit the whip thread to slip over one end; and for this reason, on a plain foundation, the moves at the edge of a figure are always in even numbers.

The whip threads are carried by eyed needles A (Figs. 317 and 318) fixed in the needle bars B, each of which is separately supported by a shifter frame C. Although a loom is usually fitted with four needle bars and shifter frames, only as many are employed as are necessary in forming a design, the remainder being left out of action. The distance that the needles project varies with the position of a bar, and may be 3 inches in the first bar, and project $\frac{1}{8}$ inch farther at each succeeding bar, in order that they will conform with the line of the shed. The needle bars are below the ground warp threads—the cloth being woven wrong side up, and each bar, when in action, has a sequence of the following movements:—

(1) A rising movement to bring the needle eyes about level with the top line of ground threads, in which position they are retained while a weft pick is inserted to stitch the whip threads into the ground fabric. During this movement the reed is moving back from the edge of the cloth. (2) A falling movement, during which the reed is moving forward, which brings the needles below the lower line of warp. (3) A horizontal movement to the left, by which the whip threads are traversed for the required distance in forming the pattern. The rising movement is then repeated, and the whip threads are stitched in by the second pick in their new position; the needles fall again, and this is followed by a fourth movement in which the bar is traversed to the right.

As the needle bars B are required to raise the needles into the shed opening in front of the reed, it is necessary for the latter to be placed back from the race-board. The lower part of the reed is, therefore, carried in a semi-circular trough D, Fig. 317, which is supported by brackets, one at each side of the reed space. The brackets are secured by bolts to the slay, while the slay cap E, which holds the upper part of the reed, is also fixed behind the slay by means of bolts. The position of the reed necessitates the provision of a bar F, Fig. 317, termed a pin bar, that carries a number of vertical pointed pins placed about 1¼ inches apart, which, at every pick of weft, are projected into the shed opening in close touch with the back edge of the race-board. The pin bar simply rises and falls, and has no part in the formation of the pattern. The function of the pins is to serve as a false reed, in place of the ordinary reed, in guiding the shuttle in its passage across. The pin and needle bars move to and fro with the slay; and in Fig. 317 they and their supports are represented in their most backward position by the solid lines. The dotted lines show their position when the reed is in contact with the cloth. On account of the reed being placed back, a much longer sweep of the slay—about 8 inches—is necessary than in ordinary looms. Instead of the ordinary cranks, the fast pulley and the gear-wheel to the bottom shaft are placed at opposite extremities of the driving shaft, and are provided with bolt holes, the bolts in which form the fulcra of the connecting arms.

The threads for each needle bar are wound on a separate small beam, and in mounting the loom the rolls are placed in suitable supports G, Fig. 317, bolted to the loom framing. The whip threads from each roll are passed in front of the lower and behind the upper cord of a tensioning arrangement H, between the heald cords, then under the reed casing, and finally are drawn through the eyes of the corresponding needles. A separate tension device H is required for each needle bar, because the length of the whip thread, from the cloth to the roll, varies with the rise and fall of the bar. Delicate adjustment of the tension is necessary in keeping the whip threads sufficiently tight to prevent them from curling on the face of the cloth, while at the same time the ground texture is disturbed as little as possible. The parallel cords of H, which extend across the warp, are attached to wooden end pieces, and are given the necessary spring as follows:—The ends of a strong cord are passed inward through two holes equidistant from the centre of each end piece, and are secured. The looped end of each cord is then passed through a hole in a bracket, and a small piece of wood is inserted in the loop. By turning the pieces of wood round, twist is put into the cords, the amount of twist being varied according to the degree of tension required. The spring cords readily give off and take up the whip warp in accordance with the movements of the needle bars.

Rotation of the Pattern Wheel.—The wheel K, Fig. 318, made of hard wood about $\frac{7}{8}$ inch thick, is mounted behind the shuttle box with its centre rather higher than the upper side of the shifter frames C. Its central stud is supported by means of a bracket bolted to a slotted rail *z* (fixed by a bolt to the sword) in such a manner that lateral adjustment, according to the size of the wheel, is readily made. A number of teeth, equal to, or a multiple of, half the number of picks in the repeat of the design, are cut on its periphery, and it is turned one tooth at every two picks, as follows :—A bowl L, adjustably carried by a bolt fixed in a slot in the low shaft gear-wheel, engages the surface of a flat plate screwed on the upper side of a lever M, fulcrumed at N, Fig. 317. The lever M is thus depressed once in two picks, and by means of the connecting rod O, Fig. 318, lever P, and catch holder Q, the spring catch R is raised high enough to engage the next tooth. Immediately the bowl L has passed the centre of its action on the lever M, the downward pull of a strong spiral spring S causes the catch R to be depressed, and the wheel is thus rotated one tooth. The height to which the spring catch R is raised is varied in accordance with the pitch of the teeth, and the downward pull of the spring S is arranged to bring the edge of a tooth in a horizontal plane with the centre of the wheel. In order to prevent the wheel overrunning itself, its rim at the back is cut away to about the depth of the teeth, and in the surface thus provided a groove T is cut for the reception of a brake cord. The cord is tied at one end to a bracket, and at the other end is connected to a spiral spring U, the pull of which is regulated according to requirements. The catch R is raised while the crank is moving from the back to the top centre, and its downward movement is completed before the front centre is reached.

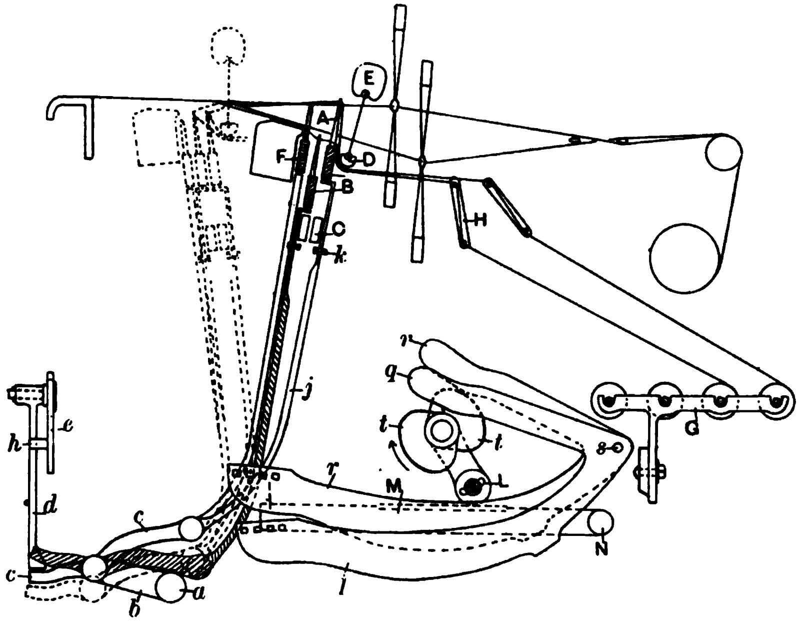

Fig. 317.

Vertical Movement of the Pin and Needle Bars.—The pin bar F is mounted at both ends with grooved brasses which fit freely over slides on the inner ends of the shuttle boxes. Each needle bar B is similarly provided at its ends with grooved brasses, as shown at V in Fig. 318, which, in this case, fit over flat vertical slides W, screwed to the top of the corresponding shifter frame C. This arrangement permits a vertical movement to be imparted to the needle bar, quite independently of its shifter frame, while the horizontal movement of the latter will be communicated to the needle bar. At the same time that a needle bar is required to slide freely in a vertical direction, it is important that there be no side play between the brasses and the slides, or the horizontal movement will be affected. To compensate for the wear of the brasses and slides a flat piece of wire may be attached to the end of a bar and passed inside the brass groove.

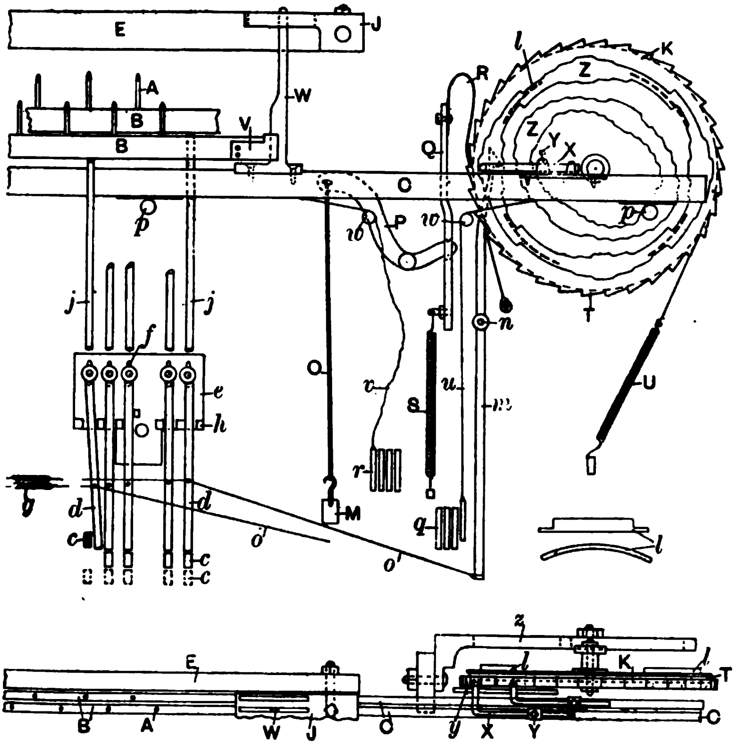

Fig. 318.

The pin bar must be raised and lowered on every pick ; and the same applies to a needle bar which is forming a continuous line of figure, such as is shown in Fig. 315. The needle bar, which produces the detached spot effect in the same design, however, will require to be thrown out of action on the picks between the spots. It is, therefore, necessary, so far as its vertical movement is concerned for each needle bar to be capable of being put into or taken out of action when required. In Fig. 317, with the slay in its backward position, one needle bar is represented as being raised, while the other is down. The bars derive their rising and falling movements from the rocking shaft *a*, Fig. 317, the partial turning of which causes the lever *b*, fixed to it, to rise and fall at its forward end. This end of the lever *b* carries a stud upon which five levers *c* are fulcrumed, the central lever being used for the pin bar, and the two on each side of it for the four needle bars. Above the front edge of each lever *c* there is a pendant *d*, carried by a slotted bracket *e*, which is bolted to the loom framing. The pendants are fulcrumed at the top, and while that for the pin bar is always over the front edge of a lever *c*, those for the needle bars are retained in their normal position by a cord connected to a spiral spring *g*, shown in Fig. 318. Projections *h* are cast on the bracket *e* in order to limit the lateral movement of the lower ends of the pendants. At the rear end of each lever *c* the extremity of a round rod *j* is fulcrumed, each rod passing through guide slots *k* to the underside of a bar. The rod, which controls the pin bar, does not need to be specially shaped at the top, but on account of the shifter frames being below the needle bars, the other rods are made flat towards the top, and are bent at right angles where they are in contact with the bars. A set of five pendants and connections is provided at each side of the loom, as shown in Fig. 316, and a flat piece of metal is screwed to the underside of each bar where a rod *j* is in contact with it.

For convenience, in Figs. 317 and 318 the levers *c* are represented in three positions. When a bar is down, the rear end of the corresponding lever *c* rests with its underside on the rocking shaft *a*. As the slay moves back from the cloth the lever *b* rises at its forward end, and thus raises the fulcrum of the levers *c*, the front arms of which, therefore, press against, and are held down by, the pendants *d* (which are in the normal position), with the result that the rear ends rise and push up the corresponding bars by means of the rods *j*. As the slay approaches the cloth the forward end of lever *b* falls, and all the levers *c* assume the positions represented by the dotted lines, the pin and needle bars moving below the underside of the cloth. The bars should complete the downward movement when the reed is some distance from the edge of the cloth, and before the horizontal movement commences. With smooth working the deadweight of the parts is sufficient to bring the bars down, but in order to avoid all liability of a bar sticking, it is customary to attach one end of a light spring to the framework underneath, and connect the other end by a separate cord to each bar. The vertical distance moved by the bars can be adjusted collectively by turning the lever *b* on the rocking shaft *a*, and individually by raising or lowering the fulcrum of a pendant in a slot *f* provided in the bracket *e*.

Method of Making the Needle Bars Inoperative.—A needle bar is left out of action by withdrawing the corresponding pendant *d* from above the forward end of a lever *c*, which, therefore, rises as the slay recedes from the cloth. The weight of the needle bar and connecting rod keeps the rear end of the lever *c* resting on the rocking shaft, and the parts thus assume the position represented by the shaded lines in Fig. 317, the needle eyes remaining below the lower line of the warp. The manner in which a pendant is withdrawn is illustrated in Fig. 318. On the hind face of the wheel K a ring groove is cut, into which one or more curved pieces of metal *l*, projecting about ¼ inch, are fixed. The circumferential distance covered by a "dropper" (the shape of which is represented below the wheel in Fig. 318) is arranged to coincide with a number of teeth in the wheel, and corresponds with the period during which a needle bar will remain out of action. As the wheel K revolves, the edge of the "dropper" comes in contact with, and presses back the head of a hooked lever *m*, fulcrumed at *n*, and the lower end, by means of a cord *o*, draws a pendant away from a lever *c*. The upper end of the lever *m* is in the form of a hook, in order that it can immediately slip over the edge of a metal piece when the stationary period of a needle bar is completed. If two or more needle bars have to be put out of action at the same time, only one set of curved pieces *l*, and one lever *m*, are necessary; but if more than one bar have to be operated intermittently at different periods, a corresponding number of ring grooves is provided at the back of the wheel, each with curved metal pieces *l* and a separate hooked lever *m* and cord connection *o*. The curved pieces for the different ring grooves stand out the same distance from the surface of the wheel, and all the levers *m*, except the first, are bent sideways at the top towards the wheel, in order that each will be engaged only by the corresponding dropper. The distance between two ring grooves requires to be large enough to allow space for the hooked head of a lever *m* to work without obstruction.

Lateral Movement of the Needle Bars.—From one to four grooves Z, Fig. 318, according to the number of needle bars employed in the formation of the pattern, are cut in the face of the wheel K. A groove is about $\frac{3}{8}$ inch deep, and it is shaped in accordance with the desired movement of the corresponding needle bar. A "feeler," "pike," or "peck" X is adjustably fixed by a set-screw Y between the flanges of a metal plate fastened on the upper surface of each shifter frame. At one end a peck is made cylindrical, and is bent at right angles in order that the cylindrical end will enter a groove in the wheel. The diameter of a peck where it enters a groove is about $\frac{1}{4}$ inch, and the length of the bent portion varies according to the position of a shifter frame; that for the back frame having a short bend, while that for the front frame is much longer. The bent portions of the pecks are supported by and slide upon a smooth steel rod *y* placed between the back frame and the wheel. As the positions of the pecks are fixed by the grooves in the wheel, the relative position of the needles in the different bars is regulated by moving the shifter frames, the screw Y being released for the purpose. Very fine adjustment —to the space occupied by half a split of the reed—is possible, while if considerable adjustment is necessary the flanged plate on the top of a shifter frame may be unscrewed and its position changed.

The bent end of each peck X is moved alternately to left and right within a groove Z by the downward pull of two weighted levers *q* and *r*, fulcrumed at *s*, Fig. 317. Two tappets *t*, set opposite to each other on the low shaft, act alternately on the short upper arms of the levers; thus one is raised while the other is allowed to fall. The face of each tappet *t* is wide enough for four levers to rest upon it. Straps *u* and *v*, Fig. 318, from the ends of the lower arms of the levers *q* and *r*, are passed over guide pulleys *w*, strap *u* passing from its guide pulley to the right, and strap *v* to the left. A tappet *t*, raising the lever *r*, causes a strap *v* to hang slack, and as at this time the other tappet allows the lever *q* to fall, the strap *u* is tightened, and the shifter frame is moved to the left. At the next revolution of the driving shaft the lever *q* is raised by the other tappet, and the lever *r* is allowed to drop; thus the strap *u* hangs slack and the strap *v* is tightened, causing the shifter frame to move to the right. The upper arm of a lever *q* and *r*, when in its lower position, does not necessarily rest on the thin part of a tappet, the weight of a lever being sustained by the strap from which it is suspended. Each strap is in two parts connected by a buckle which enables the length of the strap to be conveniently regulated. The shifter frames slide on a number of small bowls *p*, a flat piece of metal being screwed to the underside of each frame where contact takes place.

The to-and-fro movement of a peck is in a line with the centre of the wheel. and its extent is limited by the width of a groove ; but the position of a peck and the corresponding shifter frame changes as the groove approaches or recedes from the centre of the wheel. The movements of the shifter frames are communicated to the needle bars by means of the vertical slides W, which move within separate slots in plates J, one of which is fixed at each side to the front of the slay cap. The needle bars taken from front to back are respectively operated from the grooves taken from the outside to the inside of the wheel. A shoulder is provided upon each slide W, in order to neutralise any tendency of a shifter frame to rise. The width of the area over which a thread can be traversed by one bar is limited by the slots in the plate J, and taking the length of a slot as $4\frac{5}{16}$ inches and the breadth of a slide as $\frac{9}{16}$ inch, which are standard dimensions, the maximum width $= (4\frac{5}{16} - \frac{9}{16}) = 3\frac{3}{4}$ inches.

In order that the whip threads will offer as little obstruction as possible to the shuttle in its passage across, the tappets *t* and the picking tappets are set in conjunction with each other in such a manner that the direction of the movement of the frames is the same as that of the pick which follows. Thus, the pick from the right follows the movement of the frames from the right, and *vice versa*, the inclination of the whip threads, when the shed is open, being in the same direction as the shuttle is travelling. The bowl L and the tappets *t* are timed with each other so that the latter are midway of their lift at about the centre of the downward movement of the catch R. The turning of the wheel K thus takes place while all the straps connected to the shifter frames are slack, and there is no tension on the pecks.

Relation of Movement of Shifter Frames to Rotation of Pattern Wheel.—The low shaft gear wheel is provided at opposite sides with slots, in which the bolts which carry the bowl L, Fig. 317, may be fixed. The turning of the pattern wheel, which occurs only once in two picks, may thus be arranged to coincide with the movement of the shifter frames, either to the right or to the left. In most designs, however, it must agree definitely with one of the movements, according to the way in which the pattern grooves have been cut. There is no hard-and-fast rule ; thus, a system may be followed, for both right and left-hand looms, of having the rotation of the wheel coinciding with the movement of the pecks—(1) from left to right, or (2) from the outside to the inside of the grooves. Each system has an advantage over the other ; thus, in the first method, a wheel can be used for either a right or left-hand loom without the timing of its rotation being changed, while in the second method the pressure on the peck, as the wheel is turning, is from the side of the groove which is farthest from the centre, and the small catches (A. Fig. 322), which it is sometimes necessary to use, are fastened on the side which is nearer the edge of the wheel. In subsequent examples it will be assumed, for convenience, that the turning of the wheel coincides with the movement of a bar from left to right.

Fig. 319 illustrates how necessary it is, in certain patterns, for the rotation of the wheel, the movements of a shifter frame, and the manner in which a pattern groove is cut, to coincide with each other. In A, which illustrates the traversing of a whip thread, as viewed from the upper or wrong side of the cloth, the vertical spaces represent the splits of the reed, and the horizontal lines the picks of weft, the pattern extending over 20 splits and 30 picks. The whip thread is shown traversing 6 and 4 splits alternately, except where the pattern turns, in which positions consecutive moves of 6 splits are made. B shows a section of the pattern wheel in which the spaces between the dotted concentric lines correspond with the splits, and the dotted radial lines with the moves to the left of the whip threads, as shown by the connecting lines; while the thick solid lines indicate the edges of the groove, which repeats on 15 radial lines, or one-third of the wheel. The width of two splits

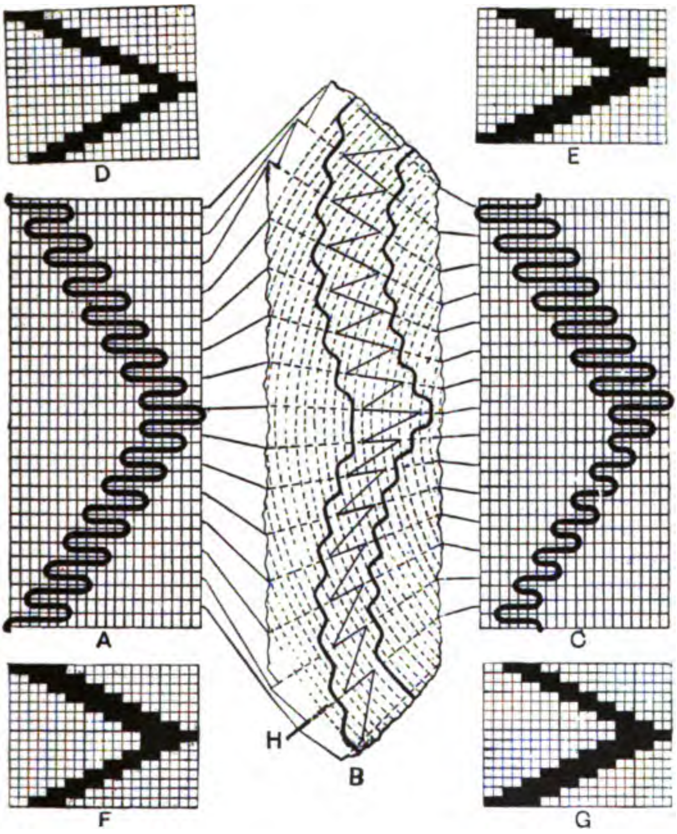

Fig. 319.

only is, for convenience, allowed for the diameter of the peck, and the groove is, therefore, shown two concentric spaces wider than the distance that the whip thread is required to be traversed. The arrangement is for a left-hand loom, and as the movement from left to right (the odd horizontal spaces of A) is taken to coincide with the turning of the wheel, the centre of the peck will traverse the concentric spaces as shown by the solid lines within the groove. It will, of course, be understood that the movement of the centre of the peck is always in a horizontal plane in line with the centre of the wheel. When the peck is moved from right to left (the even horizontal spaces of A), its centre follows a radial line, and the lateral distance traversed by a whip thread is equal to the width of the groove minus the diameter of the peck, or 6 — 2 = 4 splits in the lower portion, and 8 — 2 = 6 splits in the upper portion of B. This does not apply to the movement from left to right, as while this is about to take place the wheel turns, and the peck, therefore, moves opposite a new position in the groove ; the distance traversed being greater in this case where the inner edge is approaching the centre of the wheel, and less where it is receding from the centre. It will thus be noted that in order to obtain the alternate movements of 6 and 4 splits in each half of the pattern, the groove is narrower in the lower than in the upper portion of B ; and a representation of the form of the groove (leaving out of account the diameter of the peck), in solid marks on design paper, will not be as indicated at D or E in Fig. 319, but as shown at F.

C, in Fig. 319, shows how the pattern would be affected if the rotation of the wheel took place at the opposite movement of the shifter frame to what the groove has been cut for. In that case the turning of the wheel would coincide with the movement of the peck from right to left, and, compared with A, the traverse of the whip threads would be curtailed by the lower portion of the groove, and increased by the upper portion. With the latter timing of the rotation of the wheel, in order to produce the effect given at A, the groove would require to be cut according to the plan indicated at G. Further comparison will show that, leaving out of account the diameter of the peck, the width of a groove is determined by the distance to be traversed at the opposite movement to that which coincides with the turning of the wheel. By noting the position of the shuttle when the catch is at its highest point, the timing of the movements can be readily determined. Thus, if the shuttle is in the left box when the catch is raised, the turning of the wheel coincides with the movement from the left, and *vice versa.*

In giving instructions for the cutting of a wheel, it is necessary for the hand of the loom to be stated, in order that the teeth may be shaped accordingly. It will be noted in Fig. 316 that the wheel is at the opposite side of the loom to the driving pulley, and the turning catch acts upon the inner edge. Frequently, however, it is necessary to use a wheel for a loom of the opposite hand to that for which the teeth have been cut. The wheel is then modified to suit by driving in staples in close contact with the edges of the teeth, as shown at H in Fig. 319. The turning catch then acts upon the projecting portions of the staples. By turning the illustration round from top to bottom, it will be seen that if the rotation of the wheel again coincides with the movement of the peck from left to right, the pattern will be exactly the same as is produced in a left-hand loom, but the peck will be against the inner edge of the groove when the wheel commences to turn. The usual effect of changing a wheel is simply to turn the figure the opposite way up.

Construction of a "Common" Lappet Wheel.—A lappet wheel is made of hard wood which is close in the grain, and well seasoned in order that it will resist atmospheric changes. Its thickness is from ¾ to 1 inch, and its diameter varies from about 8 to 25 inches, according to the number of picks in the repeat, and number of frames employed in forming a pattern. A hole is bored, about the centre of a piece of wood of suitable size, to fit the socket of a lathe, in which it is turned to the proper diameter. On the side of the wheel where the groove or grooves are to be cut, a steel comb is pressed while the disc is revolving, a number of concentric lines thus being made, the space between which corresponds with the pitch of the comb.

Combs are made to suit different reeds, and for below about 34 splits per inch it is usual to use a comb of the same pitch as the reed for which the design is intended. With more splits per inch the fineness of the marking presents a difficulty, and a comb may then be used which is one-half the counts of the reed, the half distance between the marks being judged by the eye in indicating the shape of a groove. The circular lines may be marked to within about $\frac{1}{2}$ inch from the edge of the wheel, and another line is then marked about $\frac{3}{16}$ inch from the edge to indicate the depth of the teeth. The circumference is next divided into as many equal parts as the number of teeth required, each tooth representing two picks, and straight lines are drawn from the divisions to the centre of the wheel. The teeth are then then cut the required depth with the edges in line with the radial lines. Each engagement of the turning catch brings a radial line in a horizontal plane with the centre of the wheel, and the centre of a peck moves upon this line.

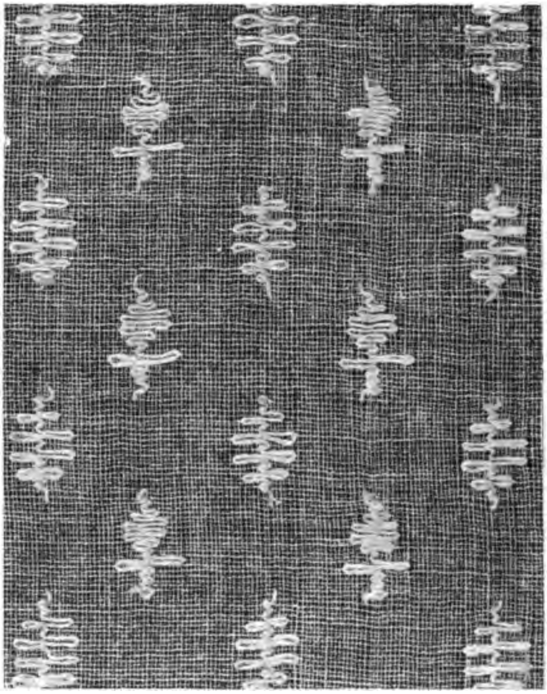
Fig. 320.

Methods of Indicating Lappet Designs.—In very many cases the wheel cutter is simply provided with a sketch of the figure that it is desired to produce, and he prepares the plan from which the wheel is cut. In constructing a plan for the wheel-cutting squared paper may be used with advantage; and in order that comparisons may be made, different methods of representing a figure are shown in Fig. 321, in which each plan corresponds with the pattern given in Fig. 320. The design repeats on 50 ends and 42 picks, or 25 splits of the reed, and 21 teeth of the wheel, and the differently shaped figures, arranged in alternate order, are formed by one needle bar. A in Fig. 321 shows exactly how the whip threads are traversed in the cloth as viewed from the wrong side, each vertical space representing an end, and each horizontal line a pick. The dotted lines show the portion of thread which is cut away after the cloth is woven, leaving the figures quite detached from each other. If the counts of the design paper is suitable for the proportion of ends and picks in the cloth, this method gives an accurate representation of the effect; but it is not convenient for the wheel cutter, since two vertical spaces correspond with one split of the reed, or one circular space of the wheel. By using paper in which each large square is divided into spaces in the same proportion as the splits per inch are to the picks per inch—as, for example, for a square cloth into 4 spaces vertically, and 8 spaces horizontally—a convenient representation of the design may be made. Thus, B in Fig. 321 shows the design A worked out on 4 × 8 paper, each vertical space of which represents a concentric space in the wheel and each horizontal line a pick. The full width of the repeat is not shown in this plan, as the wheel cutter is concerned only with the space over which a thread is required to be traversed. The accurate repetition of the figure in width is dependent upon the spacing of the needles in the bar. In the method shown at B the outline of a figure may be first drawn to scale on the paper in the ordinary manner, and then the required moves be indicated, as represented in the example.

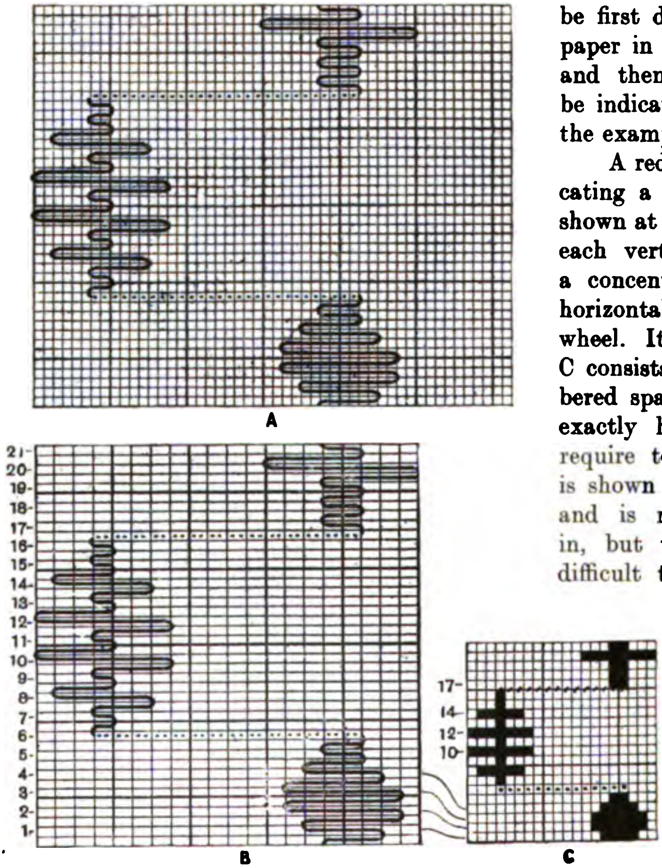

Fig. 321.

A reduced method of indicating a wheel-cutting plan is shown at C in Fig. 321, in which each vertical space represents a concentric space, and each horizontal space a tooth of the wheel. It will be noticed that C consists simply of the numbered spaces of B, and shows exactly how the groove will require to be cut. A design is shown in proper proportion, and is more readily marked in, but the moves are more difficult to follow than in the system shown at B; but if it is thoroughly understood that the marks, taken horizontally on each space, represent the distance traversed by the peck in one of its movements, say from right to left, the method is quite appropriate for the simpler styles of figures.

Method of Indicating a Pattern Groove.—A system of indicating the edges of a pattern groove is illustrated in Fig. 322. The example corresponds with the effect represented in Figs. 320 and 321, and the marking of the groove will be readily followed by comparing it with either B or C in Fig. 321. The arrangement is for a left-hand loom, and the full repeat of the design is represented on one-half of the wheel. The moves to the left in B, Fig. 321, are numbered to correspond with the similarly numbered radial lines of the wheel, and the first vertical space in the plans B and C coincides with the first concentric space in

Fig. 322. Commencing with the position marked 10, where the whip thread is at its farthest point to the left, the outer edge of the groove is marked on the first concentric line. At 11, the edge is marked on the fourth line, or three spaces inward, at 12 on the first, at 13 on the fourth, at 14 on the second, at 15 and 16 on the fourth, and at 17—where the groove changes position for the commencement of the other figure—on the fourth, and also on the sixteenth line, or 15 spaces inward. The position of the outer edge is thus indicated, where the concentric lines cross the radial lines, until the complete circle of the wheel has been made.

In marking the position of the inner edge, it is first necessary to find the width of the groove at one position, by adding the number of spaces which the diameter of the peck is equal to, to the number of spaces traversed by the peck at this point. If the diameter of the peck is ¼ inch, with 32 spaces per inch, 8 spaces are added to the traverse; with 20 spaces per inch, 5 spaces, and so on. (Sometimes the bent end of the peck is made smaller by filing it, or larger by beating it flatter, in order to adapt it to a fraction of a space, or to slightly increase or decrease the traverse in a given groove.) In Fig. 322 4 spaces are allowed for the diameter of the peck, and commencing with the position marked 10, it will be noted that the traverse is 7 spaces; therefore the inner edge of the groove at this point is 4 + 7 = 11 spaces distant from the outer edge. When one position has thus been found on a radial line, the concentric lines are successively marked in the manner described in reference to the outer edge. When the lines of the

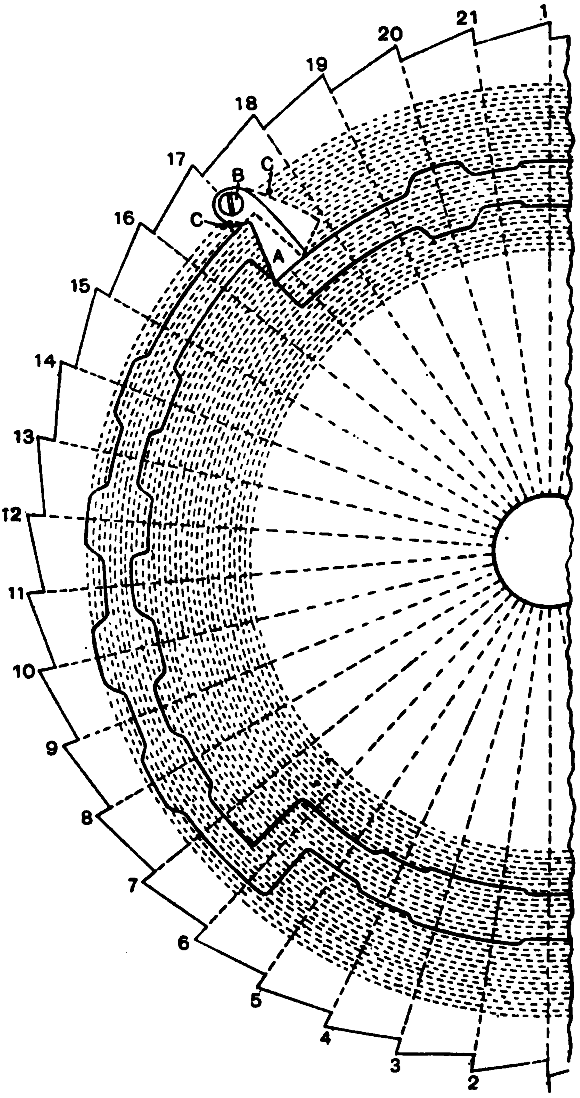

Fig. 322.

groove have been completed, the wood between them is carefully bored out to the required depth—say $\frac{3}{8}$ inch.

In an ordinary groove two concentric lines are sloped towards each other intermediate between two radial lines, but when the groove changes abruptly towards the centre of the wheel, as shown on the radial line numbered 17 in Fig. 322, the peck is liable to catch against the approaching edge of the groove as the wheel revolves. This will be understood if the moves of the peck, in relation to the turning of the wheel, are followed. Thus, taking the radial line 16, the peck moves from the inner to the outer edge of the groove, then the wheel turns, and while this is taking place the peck is really in easy contact with the outer edge. After the rotation of the wheel the peck moves on the line 17 against the inner edge, then it moves back on the line 17, and this is followed by another rotation of the wheel. If allowed to pass the corner of the outer edge in moving back, the peck would lock the wheel, and in order to avoid this a small catch A, centred freely at B, is provided. When the peck is moving on the line 17 from the outer to the inner edge of the groove, it pushes up the catch A to the position shown by the dotted lines; but when the return movement takes place the catch has dropped and the peck moves against its edge. The catch is shaped in conformity with the edge of the groove, and two pins C are driven into the wheel to limit the extent of its movement.

There is a similar abrupt change in the position of the groove on the radial line 6, but as the move is away from the centre of the wheel no catch A is necessary. Thus, on the radial line 5 the peck moves from the inside to the outside of the groove; the wheel turns, and the peck moves against the inside on the line 6, then on the same line against the outside, and while it is in this position the wheel turns again. The catch A requires to be placed on the side of the groove that the peck is in contact with when the wheel commences to turn. Thus, in the case of adapting the wheel represented in Fig. 322 to a right-hand loom, it would be necessary to change the position of the catch to the inside of the groove.

A feature to note in Figs. 319 to 322 is that each design repeats on an odd number of teeth of the wheel. This is frequently necessary when a perfectly balanced or symmetrical effect is equired. Thus, in Fig. 319, in order that both turning points of the waved line will be exactly the same, it is necessary for the half repeat to be made on an odd number of picks, while in Fig. 321, in obtaining the moves from one spot to the other without the needle bar dropping, it is necessary for an odd number of picks to be employed for each figure. An even number of teeth could be employed for a style such as the latter by making one figure 2, or 6, etc., picks longer than the other.

Continuous Two-frame Lappet Design.—The pattern in Fig. 323 shows a style of ornament produced by two frames working in combination, which are continuously in action. The corresponding plan is given at A in Fig. 324, as viewed from the wrong side of the cloth, the vertical spaces representing the splits of the reed, and the horizontal lines the picks. The repeat is on 32 splits, and 70 picks, or 35 teeth an odd number of the latter being arranged for on account of the figure being symmetrical. The full squares show the moves of the first needle bar, and the dots of the second, while the circles indicate the moves of both bars. The marks on the odd horizontal spaces represent the moves from right to left, which decide the widths of the grooves. There are three features to note in this example. (1) Where two whip threads unite to form a solid portion of figure it is necessary for the traverses to overlap. If the threads approach each other without overlapping, the side pull in opposite directions is liable to distort the ground ends unduly, and make an open space between the two portions of the figure. In obtaining the overlap the needles do not cross each other, as both bars move in the same direction. (2) It is necessary for the distance from centre to centre of the needles in each bar to be exactly the same as the space occupied by the number of splits in the repeat. (The spacing of the needles is considered more fully in reference to a subsequent example, p. 319.) (3) The different bars require to be set so that the needles are in correct relation with each other. Fig. 323 illustrates good and bad setting, the pattern on the right showing the whip threads overlapping more in one central figure than in the other, while in that on the left the overlap is equal, and a perfectly symmetrical figure results.

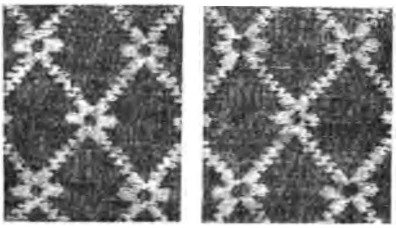

Fig. 323.

Relative Positions of the Needle Bars and Pecks.—Although the traverses of the whip threads may require to overlap in the cloth, as in the example given in Fig. 323, in the wheel it is necessary for some thickness of wood to separate the grooves at every point; therefore the relative position of the pecks is not the same as that of the needles in the bars. This is illustrated in the lower portion of Fig. 324, where the pecks are represented as being against the outer edges of the grooves, while the corresponding positions of the needles are indicated by

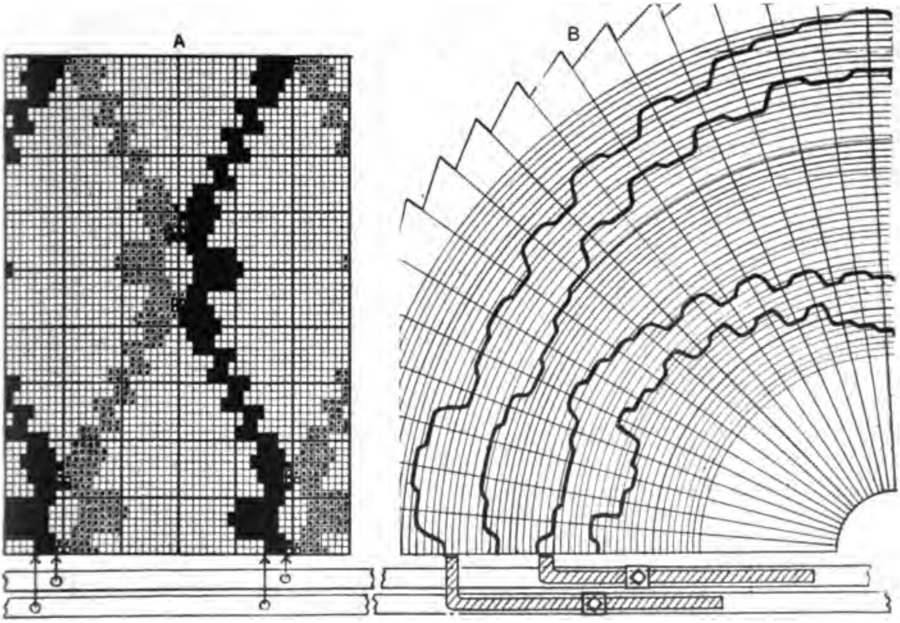

Fig. 324.

the arrows at the completion of the first traverse to the left. The needles are only three spaces distant from each other, compared with 13 spaces from centre to centre of the pecks. When a new design is introduced, repeated adjustments are made by releasing the screws which secure the pecks and moving the shifter frames until the needles in the respective bars are in the correct relative position for producing the desired effect in conjunction with each other.

Intermittent Three-frame Lappet Style.—Fig. 325 shows a detached spot pattern in which the figure is due to three needle bars working in unison. Fig. 326 shows how the whip threads are traversed in each figure, in this case as viewed from the face side of the cloth, the vertical spaces representing the splits of the reed, and the horizontal lines the picks. The counts of the paper is 4 × 6, and is approximately in proportion to the 34 splits, and 56 picks per inch of the cloth. The centre of the figure, which is formed by a differently coloured thread, is indicated by shaded lines in Fig. 326, and it will be noted that very short traverses of the thread are made at the beginning and finish of the spot. It is customary to do this in the case of detached spots in which the floats are somewhat long, in order to prevent the threads from being plucked out during the shearing operation, and from fraying out during wear. With this provision longer floats may, as a general rule, be employed in lappet styles than in ordinary figuring, on account of the manner in which the whip threads are stitched in, and because there is a firm texture underneath the floats.

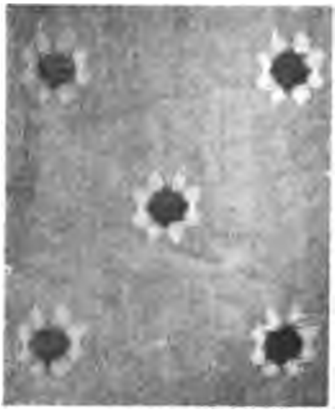

Fig. 325.

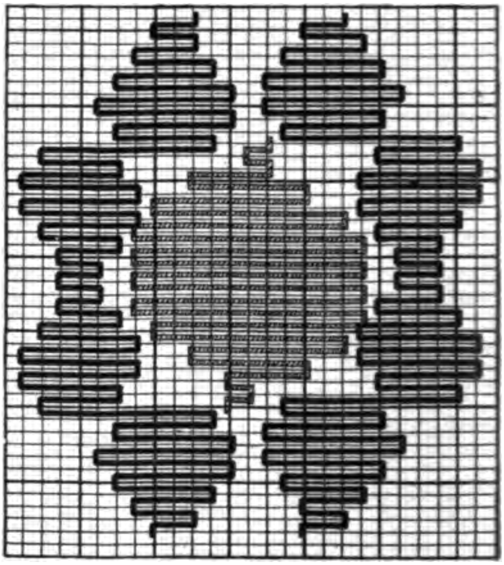

Fig. 326.

A representation of the wheel for producing the pattern in Fig. 325 is given in Fig. 327, the 6 thick lines showing the edges of the three grooves. For convenience of space, however, vertical and horizontal lines are used to represent respectively the concentric and radial lines of the wheel, while the diameter of the peck is taken as being equal to four splits of the reed. The arrangement is for a right-hand loom, with the rotation of the wheel coinciding with the movement of the pecks from left to right; and where figure is formed thicker lines are marked within the grooves to show the traverses of the threads. The illustration does not, of course, give an accurate idea of the area that a peck has to work in, as the horizontal spaces are much less in proportion to the vertical spaces than the radial spaces of a wheel are to the concentric spaces. In marking the grooves it has been taken into account that Fig. 326 shows the traverses of the threads on the face side of the cloth. If a figure is required to be inclined in one direction on the right side of the cloth, it is necessary for the groove to be cut to turn it in the opposite direction during weaving; and although not necessary in this case, on account of the figure being practically symmetrical, Fig. 327 is arranged to illustrate the principle of turning a figure over. Thus, the portion of the figure on the left of Fig. 326 corresponds with the groove on the right of Fig. 327, and the move to the right with the move to the left, and *vice versa*.

All the bars are out of action on the picks between the spots, the two which form the outer portions of the figures being active for 42 picks, and inactive for 42, while that which forms the central portion is active for 22 picks and inactive for 62. The bars, whose active and inactive periods coincide, can be operated from the same ring groove at the back of the wheel; therefore, for the three bars two sets of curved metal pieces in separate ring grooves and two hooked levers will be required. The solid black vertical lines in Fig. 327 show the periods during which the bars will remain out of action, the number of horizontal lines which each covers representing the number of radial lines which will be covered by the corresponding curved metal piece. It will be noted that each terminates about midway between two teeth. Between the figure portions, the grooves are made wide enough to give free movement to the pecks.

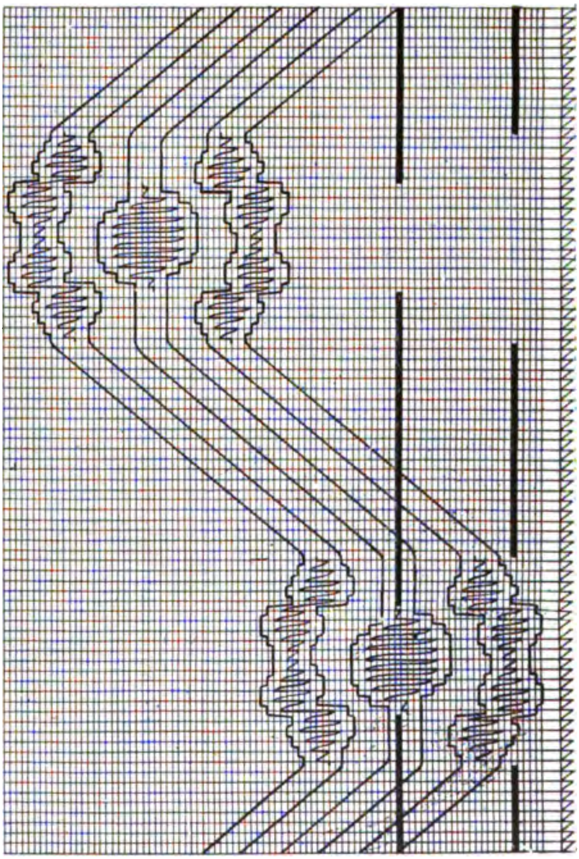
Fig. 327.

In a drop pattern of this type it is necessary for the figures to be placed at equal distances apart. So far as regards the cutting of the wheel, therefore, it is necessary for the position of a groove of one figure to be half the total number of radial spaces distant from the corresponding position of the groove of the other figure. The distance from centre to centre of the needles in each bar can be obtained by noting on the wheel the concentric width between two corresponding positions of a groove. Thus, in Fig. 327 the number of vertical (representing concentric) spaces that the grooves move inward from the first to the second figure is 42, therefore the number of splits of the reed that the needles in each bar will require to be apart is twice this number—viz., 84.

Continuous All-over Three-frame Lappet Design.—The pattern given in Fig. 328 illustrates the production of a floral style by means of three needle bars working in combination, each of which is continuously in action. The corresponding plan, as viewed from the face side of the cloth, is shown in Fig. 329, the vertical and horizontal spaces in which coincide respectively with the splits of the reed and the teeth of the wheel. Different marks are used to represent the traverses of the different bars, while

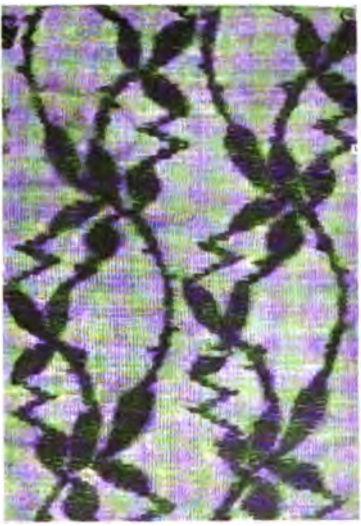

Fig. 328.

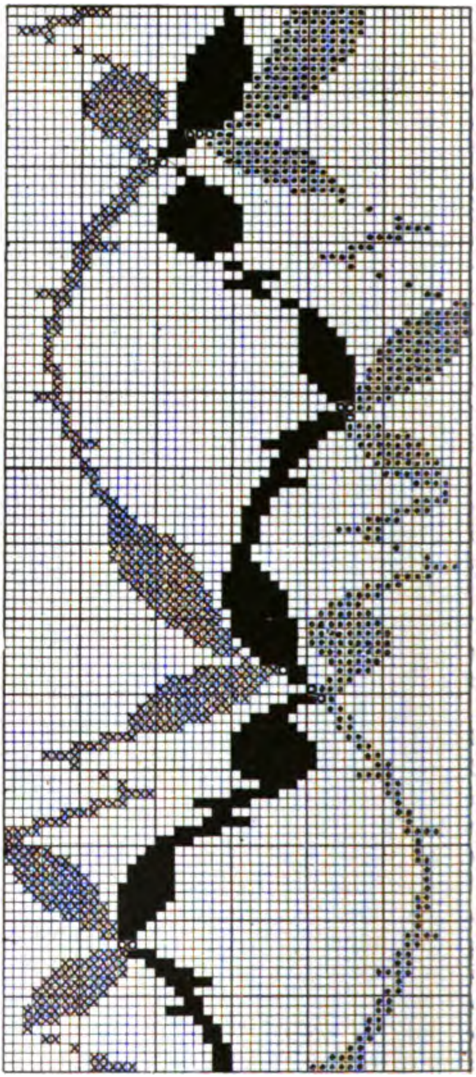

Fig. 329.

the circles show where the working of two bars coincides. The marks, taken horizontally, represent the number of splits traversed by the threads from left to right, on the face side ot the cloth; and the diameter of the peck, added to the spaces marked, gives the widths of the respective grooves. Although the traverses overlap in certain places, the needle bars never cross each other. The example is illustrative, in particular, of how one thread may be used to form a portion of a figure, which is then continued by the working of another thread while the first thread is forming another portion. It will be noted that the repeat is on an odd number of horizontal spaces—viz., 113. The pattern is a half-drop style, and an odd number of teeth is necessary in getting the traverses exactly the same in both halves, the pattern being turned on the half of a tooth. The marks in the upper half of the plan are not the same as in the lower half, although the figure is the same; the grooves, which produce similar parts of the design, requiring to be different in width because the figure is turned in opposite directions in the two halves. The design repeats on 48 splits, and the needles in each bar will, therefore, require to be placed exactly 48 splits from centre to centre, although the threads are actually traversed over 49 splits, one split being allowed for overlap in order to give an all-over appearance to the design across the cloth.

Crossing the Needle Bars.—The pattern shown in Fig. 330 results from four needle bars working in unison, each of which is continuously in action. The corresponding plan is given at A in Fig. 331, as viewed from the face side of the cloth, different marks being used to represent the working of the different bars, and circles to show where two bars coincide. The marks on each horizontal space represent the distance traversed by the threads from left to right on the face side, or from right to left as the cloth is woven. A special feature of the example is the crossing of the needle bars, the first and second crossing each other, and the third and fourth. It is usual in such a case to draw the whip threads between the heald cords and under the reed casing in the ordinary manner. When in the crossed position, a thread is at an angle from the needle eye of one bar to the opposite side of a needle in the other bar. This is illustrated at B in Fig. 331, which represents the positions of the needles in bars 1 and 2 when raised after the first move to the right. The arrows indicate the direction of the threads after passing under the reed, while the crosses show where the threads are attached to the cloth previous to the move. No special difficulty is caused by the crossing of the threads, except that extra care is necessary in adjusting the tension, and, on account of the greater strain, breakages are more frequent, necessitating the use of a superior quality of whip yarn. It should be noted in this example that there would have been no necessity for the crossing of the threads if they had all been of the same colour. In that case each thread would have formed the figure in a straight line of the cloth, simply overlapping where the figures intersect and then turning back in the manner represented in Fig. 329.

C in Fig. 331 shows the marking of the grooves for producing the lower portion of A wrong side up—that is, with the design turned over, as indicated by the numbers below A and C. In C each vertical space corresponds with a concentric space of the wheel, and with a vertical space of A; while each horizontal line coincides with a radial line of the wheel and a horizontal space of A. The traverses of the threads are indicated within the grooves, which are numbered as for a left-hand loom; and the latter are so arranged in relation to the design that the crossing of the bars 1 and 2 alternates with the crossing of the bars 3 and 4, thus equalising the strain. This is better than having all the bars crossing at one period, and then all working in the straight position at another period, which would be the case if the grooves for the first and second threads were transposed.

To find the Diameter of a Wheel—The repeat of the design given in Fig. 331 is on 138 picks and 168 ends, or 69 teeth of the wheel and 84 splits of the reed. The needles in each bar will, therefore, require to be placed exactly 84 splits of the reed from centre to centre. The threads are actually traversed over 87 splits, and rather more than the full width of the design is given at A in Fig. 331, in order to show where repetition occurs. The grooves of the wheel, however, require to occupy very many more concentric spaces than 87, because at every point it is essential for them to be kept some distance apart; while in each groove it is necessary for an allowance to be made for the diameter of the peck. This is illustrated at C, in Fig. 331, in which 10 spaces are allowed for the width between the grooves where they are nearest in contact, and 6 spaces for the peck. With these allowances the total number of concentric spaces occupied by the grooves is 182, which, with 24 splits per inch, gives 7½ inches of concentric width of the wheel, compared with 3½ inches which the repeat of the design occupies. It should be noted that each vertical space in C, although only shown half the width, represents the same width as a vertical space in A.

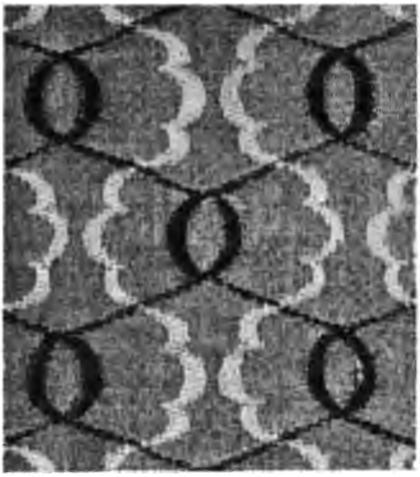
Fig. 330.

It will be evident from the foregoing that the number of teeth (or number of picks in the repeat) and the concentric width occupied by the grooves will influence the size of a wheel. A large wheel is always necessary when the number of teeth is considerable, and may also be required for a small number of picks in the repeat if the grooves occupy a large space. A peck should not approach nearer the centre of a wheel than where the space between two radial lines is equal to its diameter, and if the changes in the innermost groove are abrupt, not so near, while a small space must separate the outer groove from the edge. It is usual for the grooves to be cut as far from the centre as the size of a wheel will permit, as this gives more play for the pecks, and greater certainty of action. Assuming, for the purpose of comparison, that the pecks are ¼ inch diameter, and the radius of a wheel is 12 inches, which is about the usual maximum: with the teeth ½ inch pitch there will be 150 teeth to the round, and ¼ inch of space between the radial lines at 6 inches from the centre. A pitch of ¾ inch, on the other hand, will give only 100 teeth to the round, but there will be ¼ inch of space between the radial lines at 4 inches from the centre, the concentric width available in the latter case thus being 2 inches greater than in the former. Assuming, further, that in the latter case ½ inch of space is allowed at the outer edge, and 4½ inches at the centre, the space available for the grooves will be $12 - (\frac{1}{2} + 4\frac{1}{2}) = 7$ inches.

In deciding upon the size of wheel for a given pattern it is therefore necessary to take into account that a smaller diameter reduces the space available for the grooves in two ways: (1) because the radius is smaller, and (2) because the consequent reduction in the pitch of the teeth decreases the space between the radial lines, and thus increases the limit as to distance that the innermost groove may approach to the centre. Taking Fig. 331 as an illustration, with the diameter of the peck ¼ inch, the following method may be employed in ascertaining the size of a wheel for a design. The distance from the centre of the wheel, where the space between the radial lines is equal to the diameter of the peck, is

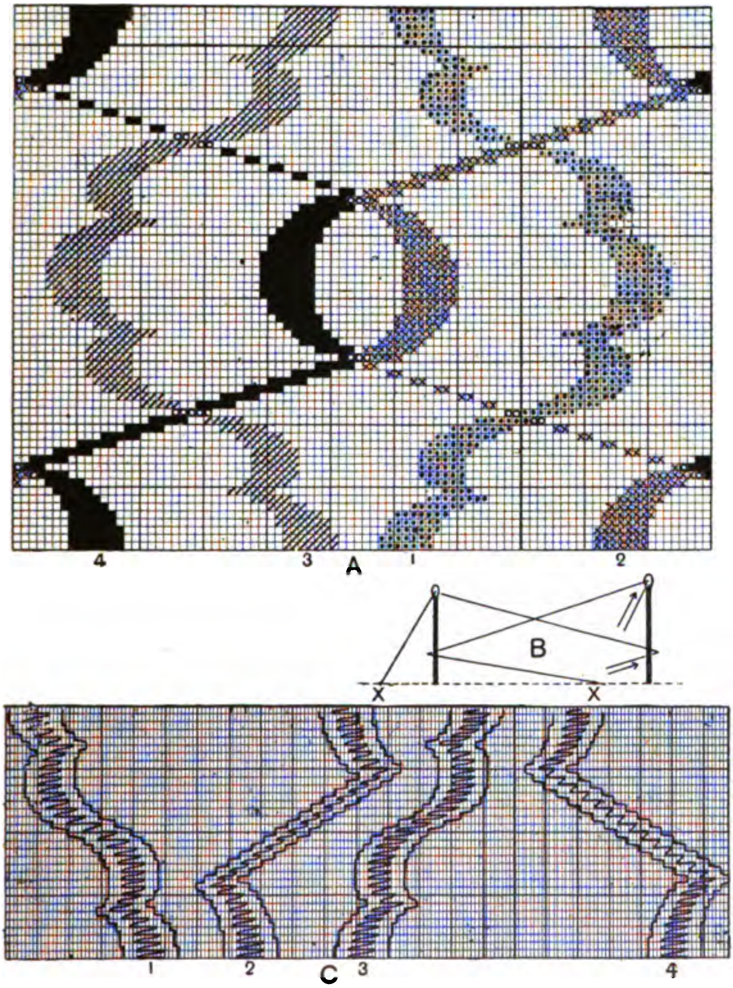

Fig. 331.

found thus :—(69 teeth in the repeat × ¼ inch) ÷ (3·1416 × 2) = 2¾ inches. The concentric width occupied by the grooves is 7½ inches; therefore, with an allowance of ½ inch at the edge, the radius of the wheel will require to be at least equal to 2¾ + 7½ + ½ = 10¾ inches, or 21½ inches in diameter. Better results, however, will be obtained by increasing the distance from the centre to the innermost groove, and a wheel of 23 inches diameter may, therefore, be used, which will give approximately 1 inch as the pitch of the teeth. In the cloth the repeat in width of a design may be greater or less than the width occupied by the grooves, according to the way in which the needles are spaced, and to how the different bars are placed in relation to each other.

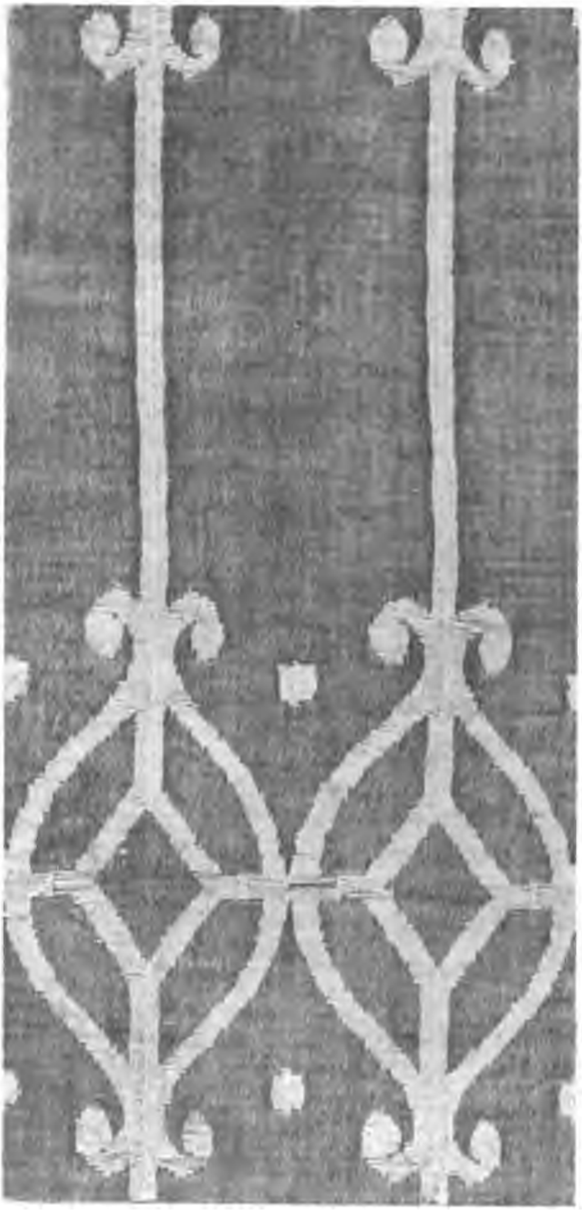

Fig. 332.

In deciding upon the concentric width which any one groove may occupy, it is necessary to take into account the length of the slots in which the vertical slides (W in Fig. 318) attached to a shifter frame move. It has previously been stated that the usual length of slot permits each bar to be traversed over a width of 3¾ inches, to which may be added the diameter of the peck in finding the maximum concentric space which may be occupied by the groove. In the case of a detached spot pattern in which the figures are distributed alternately, and assuming that the spot is ¾ inch wide, the repeat in width of the design cannot exceed (3¾ − ¾) × 2 = 6 inches.

The Length of Repeat.—The maximum number of picks in a design is usually from 320 to 350, but an exceptional example is given in Fig. 332, which repeats on 600 picks. The body of the figure is formed by 4 bars working in combination, and repeats on 318 picks; while the straight line portion is formed by 2 bars. The grooves for the latter portion, however, are only cut for a short distance, as while this is being formed the rotation of the wheel is stopped. In another method of obtaining a very long repeat from a wheel of ordinary size, the bowl, which operates the turning of the wheel, is moved laterally and thrown out of action on alternate revolutions of the low shaft. The wheel is thus rotated only once in every four picks; hence the repeat extends over four times as many picks as there are teeth in the wheel, but the method has the effect of making the figure coarser in outline.

Methods of Diversifying Lappet Designs.—In addition to the origination of new figures there are several methods of producing diversity of design in lappet styles, as, for example, by variously colouring the whip threads; by varying the spacing of the needles in the bars; by changing the position of one bar in relation to another; by leaving a proportion of the bars out of action; and by varying the interweaving of the ground ends; while two or more of the methods may be employed in combination. For example, assuming that three grooves are cut in a lappet wheel to produce the three systems of traversing shown at A in Fig. 333, the designs given at B, C, and D, and many others, may be readily produced from the same wheel. The spacing of the needles is indicated below B, C, and D by the arrows, which are shown of different lengths to correspond with the position of the respective bars. B shows an effect which can be formed by spacing the needles the same in each bar, one needle being required in each for every repeat. The shifter frames and pecks will, of course, require to be so adjusted that the all-over design will result by the three bars working in combination. C shows a change of effect due solely to varying the positions of the needles, the bars being in exactly the same relation to each other as in B. The change of effect from C to D, however, is due not only to a variation in the spacing of the needles, but in addition the relative position of the bars will require to be changed; while the example is also illustrative of a scheme of applying differently coloured threads.

Spacing the Needles in the Bars.—The correct spacing of the needles is of the greatest importance; and a method of marking the bars to show where the needles require to be driven in for the design D is illustrated at E, F, G, and H in Fig. 333. Only rather more than one repeat of the pattern is shown; but in practice, in order to reduce the liability of error, it is customary first to measure off, by means of a reed scale and dividers, the width of several repeats. The spaces are indicated on a bar over the desired width, and then each space is divided up into the required number of parts. If more than one needle bar is employed, in order to ensure that all are equally accurate the spacing of all the needles is marked, as represented at E, on a separate piece of wood, termed a "pattern stick," which is rather longer than the width of the warp in the reed. The number of the bar is indicated against each mark upon E, and the piece of wood and the bars are placed together; then with the aid of a set-square the marks are indicated on the respective bars in turn, as shown at F, G, and H. The punches used in driving in the needles are shaped so as to prevent the points from being damaged, and the lower end forms a projection which enables a needle to be driven in a vertical direction for the exact distance required; different punches being employed for the different lengths. After the needles have been driven in they are bent back, those in the rear bar being inclined until the points are directly above the edge of the bar, while those in the other bars are successively bent back a slightly greater distance. Afterwards the spacing of the needles is again adjusted, but this time each bar is laid flat in a suitable position in relation to the pattern stick, and the needles are, if necessary, bent to right or to left until their points are in exactly the proper position.

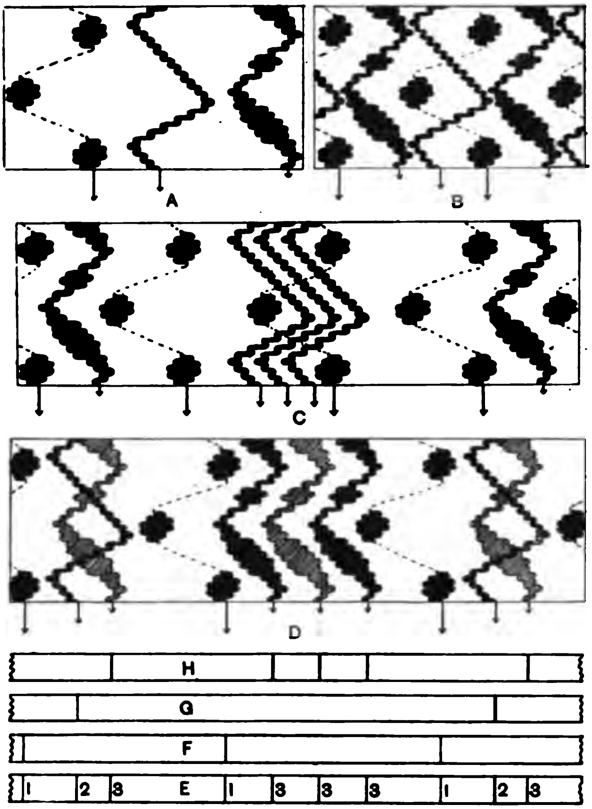

Fig. 333.

PRESSER WHEEL SYSTEM

The presser wheel system is different from the common wheel system in that the wheel is rotated one tooth at every pick, and a peck is made to press continuously against the outer edge of the groove, which is the only side of the groove that requires to be shaped according to the pattern. In keeping the pecks constantly in contact with the outer edges, the straps *u* and *v* in Fig. 318 (p. 301), and the levers *q* and *r*, are thrown out of action. On the underside of each shifter frame which is in use, and near the centre of the loom, a screw or hook is inserted to which one end of a light spiral spring is attached. The other ends of the springs are connected to a bracket which is fastened below the slay and passes under the frames. The springs are in line with the shifter frames, and the tension tends to draw the latter in the direction away from the centre of the pattern wheel; hence, as the wheel turns, there is always a certain amount of friction between the pecks, and the outer edges of the grooves. In some cases, in order to reduce the friction, larger pecks—up to $\frac{3}{8}$ inch diameter—are used; or, when very long moves are required, the bent end of a peck may consist of a specially shaped spindle upon which a small anti-friction bowl revolves where contact takes place with the outer edge. As a rule, however, the ordinary size and form of peck is found to work quite satisfactorily, and is, therefore, most generally employed, as the use of a larger peck makes it necessary for the radial spaces and the pitch of the teeth to be greater, which increases the size of the wheel and restricts the length of the repeat. On account of a tooth being required for every pick, a presser wheel requires to be larger, and is more costly than a common wheel for the same number of picks in the repeat, nor can such long patterns be obtained. There is, however, greater scope for producing diversity of effect than with a common wheel. Patterns of a less massive or solid character may be formed, as in this case the return movement of a needle bar, on alternate picks, is not essential. Consecutive moves in the same direction can be made, and waved line effects be formed, each of which is of the same width as the thickness of a thread, as shown in Fig. 334; or the whip threads may be used to form a fine outline to a simple figure, as is represented in Fig. 335. The return movement of the needle bars may, however, be readily arranged for, and variety of pattern be obtained by combining solid figures with line effects, as shown in Fig. 336. The traversing of the whip threads in Fig. 336 (slightly modified so as to reduce the size of the repeat) is shown in Fig. 337, in which the vertical spaces represent the splits of the reed, and the horizontal lines the picks, the repeat extending over 24 splits and 62 picks. Two needle bars are required in forming the pattern, and the traverses overlap by one split, giving the design an all-over character.

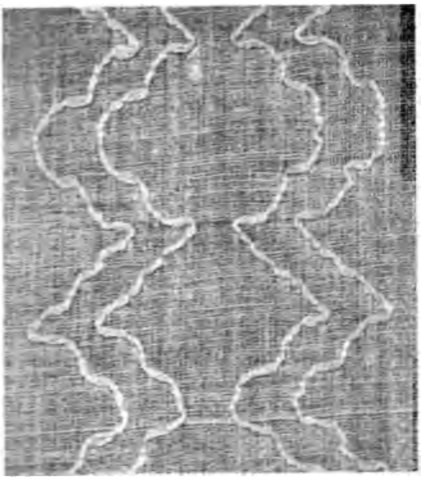

Fig. 334.

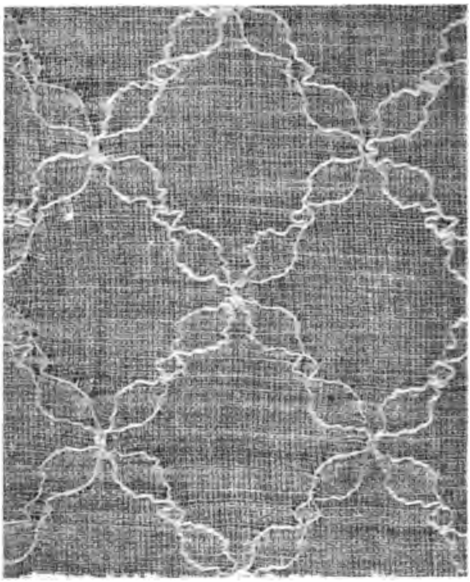

Fig. 335.

Construction of a Presser Wheel.—In constructing a presser wheel the concentric lines are marked according to the sett of the reed in the ordinary manner, but a radial line is drawn and a tooth cut for every pick in the repeat. Thus, in Fig. 338, in which the thick lines represent the shape of the grooves for producing the effect in the lower portion of Fig. 337, the wheel, which is arranged for a left-hand loom, is divided into 62 radial spaces. The radial lines correspond with the horizontal lines (or picks) of the plan, and are numbered to coincide, while a concentric space corresponds with a vertical space. As a peck is constantly in contact with the outer edge of a groove, the shape of the inner edge is of little account so long as sufficient space is allowed between the edges for the free passage of the peck. Every movement of a thread requires to be marked on the outer edge. Thus, on the horizontal line numbered 17 in Fig. 337, the first thread is 8 spaces inward; therefore, on the corresponding radial line in Fig. 338 the outer edge of the first groove is marked on the eighth concentric space. On the following horizontal lines the first thread is 10, 7, 4, 2, 5, 7, 10, etc., spaces inward in succession, and comparison will show that the outer edge of the groove is successively marked on the corresponding concentric spaces where the radial lines are intersected. The shape of the second groove is similarly indicated, care being taken in commencing that sufficient space will separate the grooves at every part.

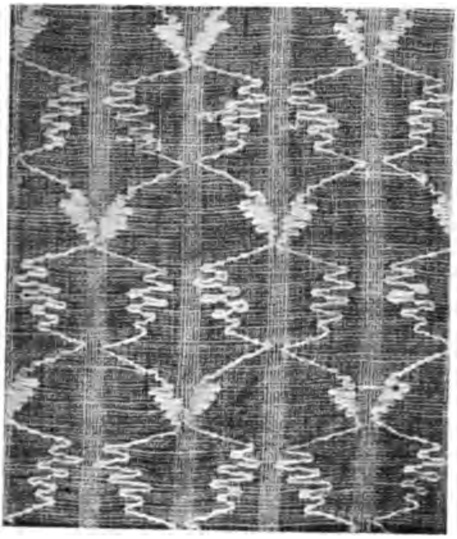

Fig. 336.

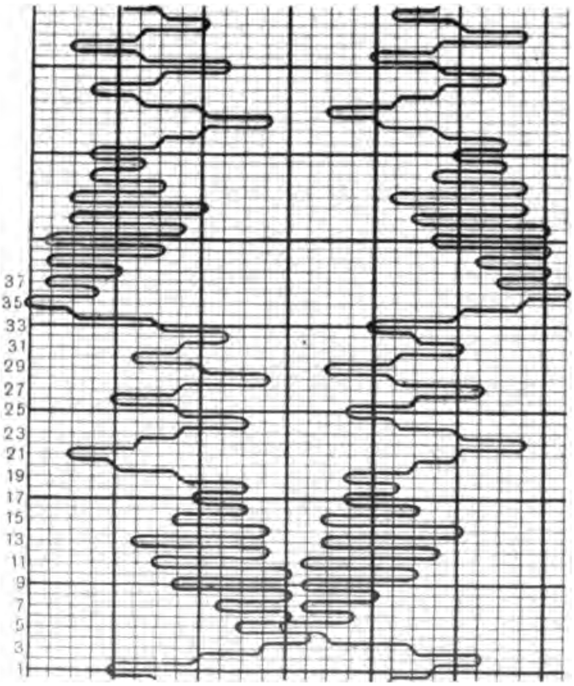

Fig. 337.

As the wheel is turned one tooth at a time, the outer edge of each groove presses a peck to the right, or permits it to be drawn to the left, according to its shape. Between the radial lines it will be noted that the shape of the outer edge varies according to whether the movement of a peck is from or towards the centre of the wheel. Where the traverses are from the centre (to the left in this case), the grooves are so shaped that the movement is almost instantaneous, the springs being allowed immediately to contract. On the other hand, where the traverses are towards the centre of the wheel, during which the springs are distended, the outer edges are gradually sloped, which prevents the wheel from being locked, and at the same time reduces the friction with the pecks. A disadvantage which arises from the grooves being thus shaped is that a wheel cannot be used for the opposite hand of loom to that for which it has been cut, as, if rotated in the reverse direction, it will be locked by the pecks.

In producing designs which include portions of a figure in which a whip thread is repeatedly traversed to left and right alternately (as on the picks 4 to 18, and 35 to 49, in Fig. 337), the spaces between the radial lines of the wheel are usually made alternately of different sizes in the proportion of about 3 to 2. This is illustrated in Fig. 338, in which the odd-numbered teeth are shown smaller in pitch than the even teeth; and it will be noted that in the solid portions of the figure the moves towards the centre of the wheel are arranged to coincide with the larger radial spaces. The friction with the picks is thus reduced when there is most strain, as a greater space gives more latitude for gradually sloping the outer edges of the grooves, and the engaging of a larger tooth provides more time for a movement. With the arrangement of different pitches of the teeth the two bowls, carried by the low shaft gear wheel, are of different sizes to correspond, the larger bowl lifting the turning catch high enough to engage the larger teeth, and the smaller bowl, the smaller teeth; but the leverage is so arranged that the small bowl is ineffective in operating a

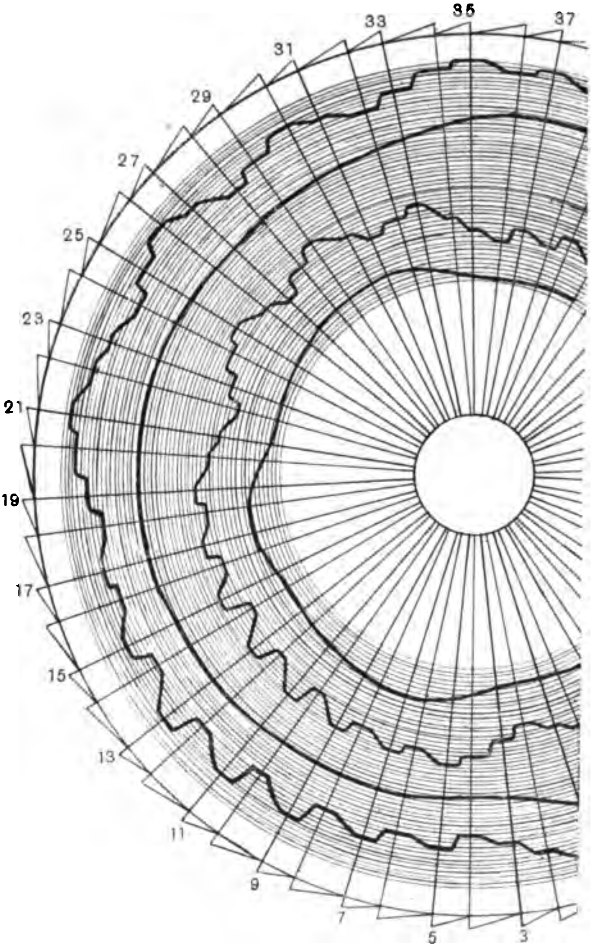

Fig. 338.

large tooth. If, therefore, the wheel gets an odd number of teeth out of proper rotation, it will remain stationary for a pick, and this gives the advantage that in the solid figure the to-and-fro movements of the needle bars are retained in correct time with the picking—an important point which has previously been mentioned. It is, of course, only in the parts of a design where the traverses are alternately to left and right that each movement of a bar can be definitely arranged to correspond in direction with the pick that follows. In the other parts of a pattern the direction of a traverse may or may not coincide with the direction of the following pick; and care is necessary here in arranging the moves, or undue friction may be caused. Thus, long moves may be more readily made if they correspond with the engaging of the larger teeth, and if each is in the same direction as the pick that follows.

To find the Length of Whip Warp.—A whip thread usually requires to be very much longer than the ground warp, the length of the former varying according to the average of the distance traversed at a movement; thus, in the same pattern, if the traverses of the threads vary, different lengths will be required for the different whip warps. Assuming that the average length of the traverses of a thread is 5 splits, and there are 20 splits per inch, $\frac{5}{20}$ or $\frac{1}{4}$ inch of whip warp will be required at every pick; and if 32 picks per inch are inserted, $\frac{1}{4}$ inch × 32 = 8 inches of whip warp will be required for each inch of ground warp. Calculations may be conveniently worked by the following rule, which gives an idea of the proportional lengths of the whip and ground warps:—

$$\frac{\text{Total splits traversed in repeat} \times \text{picks per inch}}{\text{picks in repeat} \times \text{splits per inch}} =$$

number of times the whip warp is longer than the ground warp.

In finding the total number of splits traversed by a thread it is necessary to note the moves in succession and add them together—as, for example, in Fig. 337 the first eight moves of the thread on the left are 4, 3, 2, 3, 2, 3, 3, 5 splits, which, added together, total 25. By continuing in this manner it will be found that the number of splits traversed in the full repeat by the first thread = 206. The picks in the repeat = 62, and assuming that there are 24 splits and 44 picks per inch the calculation will be:—

$$\frac{206 \text{ total splits} \times 44 \text{ picks per inch}}{62 \text{ picks in repeat} \times 24 \text{ splits per inch}} = 6{\cdot}09 \text{ of whip warp to 1 of ground warp.}$$

The calculation is more applicable to common wheel lappet designs than presser wheel styles, and at the best only gives approximately the length of whip warp that is required, as the length can be varied by the tension that is put upon the whip threads.

Lappet Styles in Imitation of Net Leno.—The presser wheel system is conveniently adapted to the production of such styles as are shown in Figs. 339 to 345, which are similar in appearance to effects produced on the gauze or leno principle. With the lappet wheel, however, there are no restrictions as regards the denting of the warp threads, as a whip thread, not being passed through the reed, may be readily made to cross a large number of splits, while one whip thread may cross another. Fig. 339 shows a style produced by two frames in which two whip threads cross in opposite directions over (or under during weaving) 11 ground ends. A flat view, of a portion of the effect, is given at A in Fig. 340, the interlacing of the threads being shown as viewed from the wrong side of the cloth in order that the order of working may be more readily compared with E, Fig. 340, which represents a section of the wheel for producing the effect. In E the thick lines show the outer edges of the two grooves, and the shaded lines the approximate position of the inner edges; while the crosses indicate where the needle bars are left down or out of action. The grooves are lettered to coincide with the whip threads, and the radial lines and picks are connected by dotted lines, and are also correspondingly numbered. The whip threads work straight for 4 picks, in the crossed position for 2 picks, straight for 10 picks, crossed for 2 picks, and straight for 30 picks, of which only 6 picks are shown at A. About the centre of the straight portions the bars are left down on alternate picks, the whip threads thus being interwoven in plain order with the weft at these places. In E six concentric spaces are allowed for moving the threads the required distance; and it will be noted that when the picks 5 and 6, and 17 and 18, are inserted, the groove W will have allowed the thread W to be drawn to the left, while the groove X will have moved the thread X to the right.

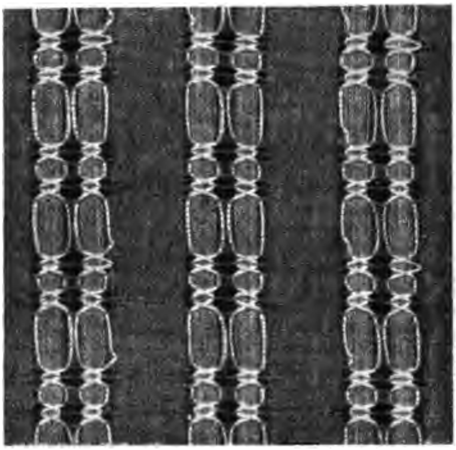

Fig. 339.

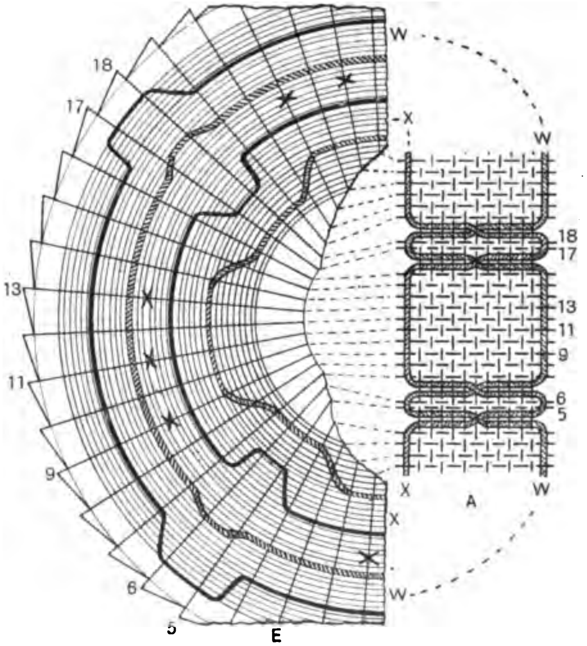

Fig. 340.

Fig. 341 shows a four-frame lappet stripe in which the threads, viewed from the wrong side of the cloth, interlace in the manner indicated at B in Fig. 342. The thick lines in F, Fig. 342, represent the form of the outer edges of the four grooves which will produce the effect, but an accurate idea of the actual space that each peck has to work in is not given, as vertical and horizontal lines are used, for convenience of space, instead of concentric and radial lines. Where a crossing takes place a whip thread is raised for three picks in succession, but in the straight portions it is raised on alternate picks only. The dots in F show on which picks the first and second bars will be left down, and the crosses the third and fourth. On the picks marked, 2, 14, 26, and 38, the groove lettered W will permit the thread correspondingly lettered to be bound in four splits (approximately) to the left of its ordinary position; while similarly the groove X will move the whip thread on the opposite side of the stripe (not shown in B), four splits to the right. The threads Y and Z move in opposite directions from one side to the other of 19 ground ends, but two traverses are made in getting a complete movement, the whip threads being bound in about the centre of the ground ends on the picks 8 and 32. The style differs in this respect from that shown at A in Fig. 340, in which the full distance is moved in one traverse; also each thread Y and Z interweaves for an equal space first on one side and then on the other side of the ground ends, whereas in Fig. 340 each thread W and X interweaves most of the time on one side only.

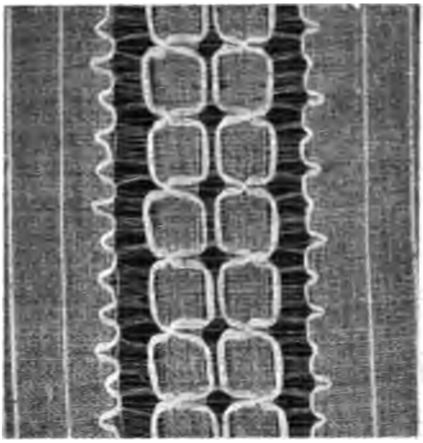

Fig. 341.

In the grooves Y and Z in F, Fig. 342, twelve spaces are allowed for moving the whip threads the distance of 19 ground ends, or about 10 splits, a larger traverse being allowed than is actually required in order that the threads will rise at each side quite clear of the ground. A number of splits of the reed are left empty between the groups of ground ends; therefore, so long as the needles rise in these places the length of the traverse is immaterial, as the tension on the whip threads draws them close against the ground stripes. The interlacing of the whip threads at the sides is clearly an imitation of doup weaving, but it will be noted that the crossing is very irregular, the thread W in Fig. 342 passing under 4, 8, 4, and 6, ground ends at successive movements. Unless there are empty splits on both sides of the ground ends which are crossed there is usually sufficient irregularity in the traverses of the whip threads in a lappet style to enable it to be distinguished from a doup effect, as in the latter whip a thread always crosses exactly the same ends.

Fig. 343 shows a style in which the whip threads do not cross, but simply approach each other and then return. The grooves for producing the effect would be similar to those represented in Figs. 340 and 342, either of which could be used to obtain a corresponding pattern by placing the needle bars in suitable relationship to each other.

The effect given in Fig. 344 is a two-frame style which is produced in a different manner from any of the others. In this case, as shown in the corresponding flat view of a portion of the stripe given at D in Fig. 345, each whip thread lettered W, during weaving, crosses from one side to the other of 11 ground ends, and is raised over every pick of weft—6 picks on one side of the ground ends, and 6 picks on the other side. The thread lettered X, on the other hand, crosses from one side to the other of a space where there are no ground ends, and is under every pick of weft, but it will be noted that it passes over a thread W where two whip threads intersect. The corresponding grooves for producing the effect are

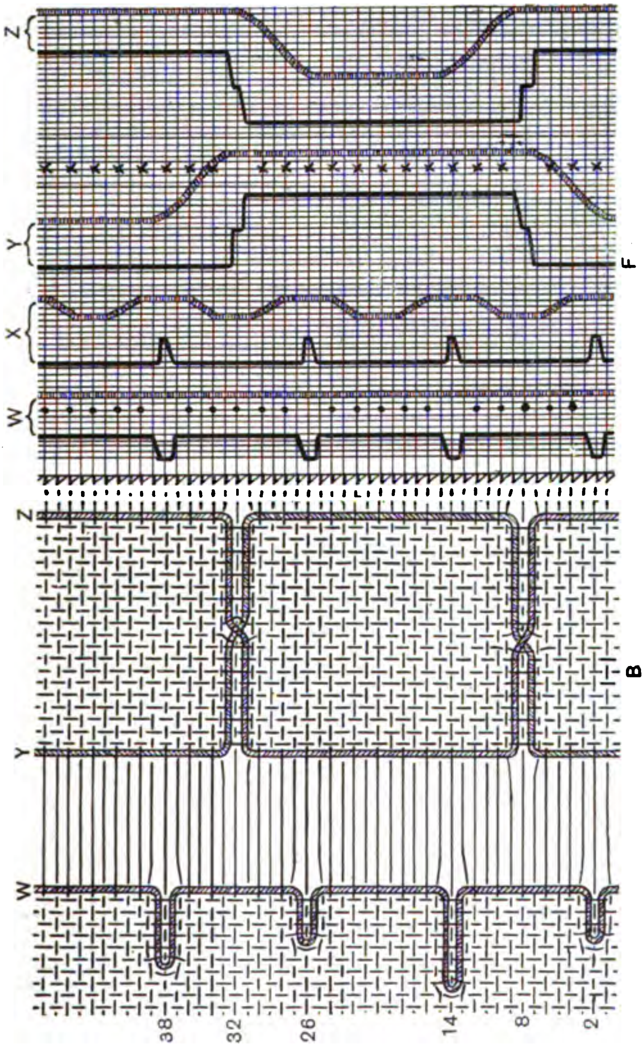

Fig. 342.

represented at G in Fig. 345, the outer edge of the groove W being arranged to move the threads W the distance of seven spaces in one direction at the same time that the groove X moves a thread X the same distance in the other direction. A feature of the style (which is more fully explained in reference to the next example) is that the threads X are never raised by the bar which carries them. Also, the two bars are set and the threads spaced in such a manner tha′ when the movements in opposite directions take place, first one and then the next thread W crosses underneath a thread X. Thus, an examination of the drawing given at D will show that on the picks numbered 1 to 6 the thread X is moved to the right, and is crossed by the second thread W which is raised on its left; while on the picks numbered 7 to 12 the thread X is moved to the left, and is crossed by the first thread W which is raised on its right. Although a thread X never passes over the weft, it is intersected and bound into the cloth by two threads W alternately, and as the tension draws the latter threads in close contact with the edges of the ground stripes, the former is held first on one side and then on the other of the space between the stripes.

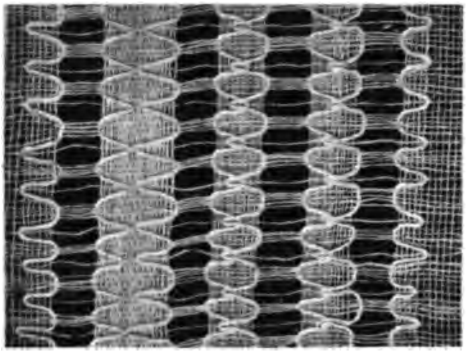

Fig. 343.

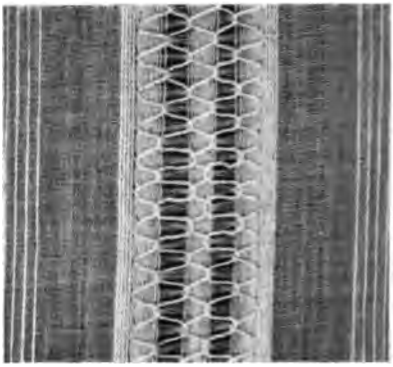

Fig. 344.

Waved Russian Cords. — Fig. 346 shows a special lappet style in which thick waved cords are formed on the face of the cloth. The effect is combined with a lappet figure produced on the presser wheel system, but in the corresponding drawings given in Fig. 347 the formation of the special cord effect only is illustrated; while for convenience of space the length of the repeat is largely reduced. In the flat view of the structure (as viewed from the wrong side), given at A, the ground ends are shown in pairs or splits working in plain order with the weft; the thick shaded line X represents a cord thread, and the solid line W a stitching or whip thread. The cord

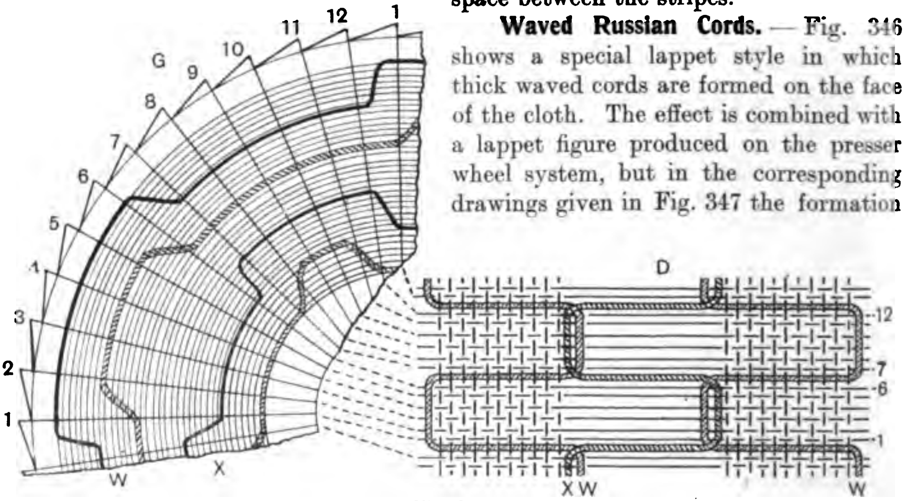

Fig. 345.

threads are never raised over the weft, but each is bound into the cloth by a stitching thread which passes below it and is raised over every pick of weft—first on one side and then on the other side of the cord. From a cursory examination of the structure it would appear that a cord thread X is gradually moved on the underside of the cloth, according to the form of waved line required, and that a stitching thread W is similarly moved, but is also traversed from one side to the other of a cord at each pick. What actually takes place, however, is just the opposite, the bar which carries the stitching threads being simply traversed according to the form of the waved line, while that which carries the cords is given the to-and-fro traverses in addition to the waved-line movement. Thus, in A, Fig. 347, the stitch thread is raised in the third split on the picks 1, 2, and 3; in the fourth split, on the picks 4 and 5; in the fifth split, on the picks 6 and 7, etc.; while the cord thread successively occupies the position represented by the dotted lines, being moved two splits to the right and left alternately of the split in which the stitch thread is raised.

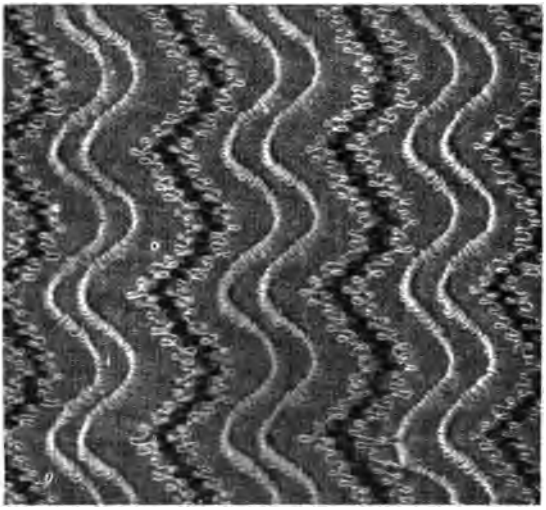
Fig. 346.

The grooves, lettered to correspond with the threads, are represented at B in Fig. 347. Usually, the arrangement for producing this style is to some extent a combination of the presser and the ordinary wheel systems. The wheel is turned one tooth at each pick, and a spring, attached to the corresponding shifter frame, keeps the peck in the groove W continuously in contact with the outer edge, as in the presser system. Both edges of each groove, however, are carefully shaped according to the pattern, and the frame which traverses the cord threads X is connected with the weighted levers (*q* and *r* in Fig. 318) as in the ordinary method; the corresponding peck thus being brought into contact first with one side and then with the other side of the groove X. In the drawing six spaces are allowed for the diameter of the pecks, the groove W being made an additional half-space wider in order to allow of a free passage, while the width of the groove X is equal to the diameter of the peck + five spaces that the cord thread is required to be traversed. The two grooves are alike except for the difference in the widths, and while in the groove W the centre of the peck will move in a line parallel with the outer edge, in the groove X the movement will be as represented by the dotted lines.

The stitching threads are carried in the ordinary manner by eyed needles fixed in a wooden bar, and the cord threads may also be similarly carried by shorter needles; but a better arrangement for the latter consists of a thin metal plate supported by the hindmost bar, which would otherwise support the needles. The metal plate may run almost the length of the reed space ; and near its upper edge it is pierced with small holes at very frequent intervals, through which, at the required places, the cord threads are drawn. The plate is about ½ inch deep, and as it is always required to be below the lower line of the warp, its upper edge is only about 1½ inches above the top of the bar. The stitch threads are drawn underneath the plate, so that when the transverse movements take place the cord threads pass above them. Very accurate setting of the two series of threads is necessary, and the grooves require to be very carefully cut in relation to each other in order that a cord thread will be moved an equal distance on each side of a stitch thread, whatever the position of the latter. The prominence of the cord effect is influenced more by the tension on the stitch threads, and the extent of the to-and-fro movement, than by the thickness of the cord threads. If the wheel gets an odd number of teeth out of proper rotation, the action of the weighted levers will be incorrectly timed, which will affect the length of the traverse of the cords ; therefore, it is better for the teeth of the wheel to be alternately of different sizes, as explained

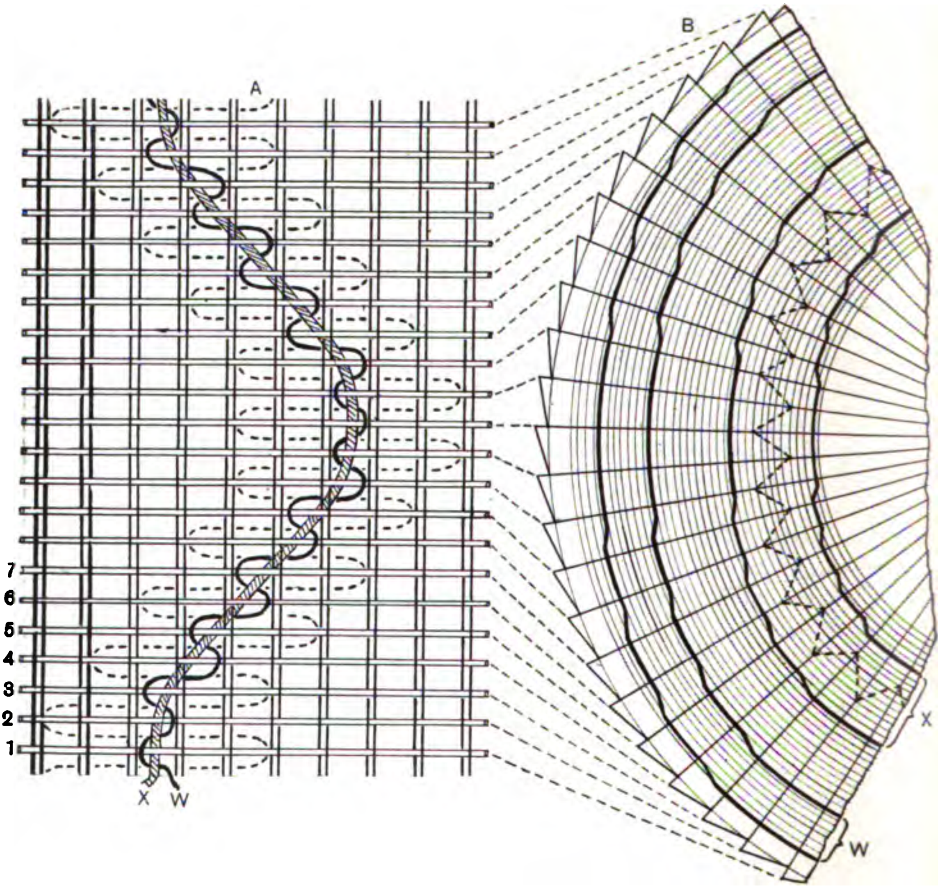

Fig. 347.

in reference to Fig. 338 (p. 323). Although the style is most generally produced on the presser-wheel principle, a common wheel can be readily arranged to give a similar result.

Imitation Lace.—A special lappet effect, which is an imitation of lacework suitable for the border of a muslin curtain, is represented in Fig. 348. The example is a two-frame common-wheel style, the pattern formed by the whip thread at each side of the stripe being produced by one frame, while the figured effect, which is formed by 15 whip threads that work differently from each other, is produced by the second. The traversing of the whip threads at the sides of the stripe is similar in principle to the foregoing examples, and, therefore, need not be dealt with here. The figure is very elaborate taking into account the means of production, and its formation is illustrative of a special principle of obtaining variety of effect in lappet work. When the traverses are to left and right alternately, a whip thread is held between the weft and the ground end that is left down nearest the inside of the extremity of a traverse ; ends which are lifted having no effect in binding in a thread. It is, therefore, possible with a dobby or jacquard shedding motion to vary a design by lifting certain ground ends at some places and leaving them down at others. It is upon this principle that the style of pattern shown in Fig. 348 is produced, the variations in the lengths of the traverses to which the figure is due resulting from the method in which certain ground ends are operated.

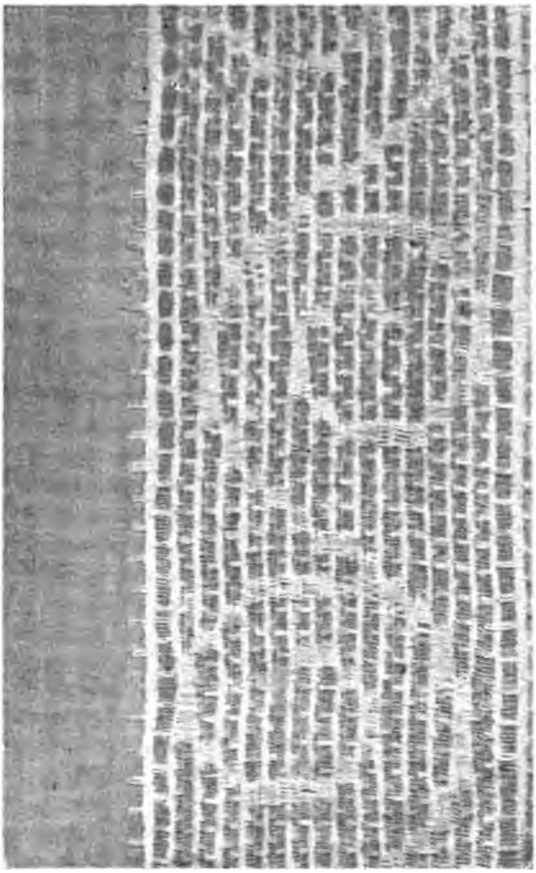

Fig. 348.

A sectional drawing showing how the figure is formed as viewed from the wrong side is given at A in Fig. 349. The ground of the cloth is arranged regularly with two ends per split, but in the figured stripe two ends, which work in perfectly plain order, alternate with a single end which is placed in one split with two empty splits at each side. The single ends do not work plain, but are operated independently, according to the effect which is required. The needle bar, which carries all the figuring whip threads, is traversed regularly to and fro for a distance that will cause each needle to be raised first on the left of a single ground end and then on the right of the next single end, as shown at B in Fig. 349. Where a single end is left down a whip thread is held by the weft against it, and a traverse across an open space is made; but where it is raised a whip thread slides along the weft until it is against a pair of ground ends, one of which is always down. In forming the ground pattern of the stripe, the structure of which will be understood if the interlacing of the whip thread lettered C be followed, the single ends are left down only on the picks numbers 4, 9, 16, and 21. In forming the figure, the single end lettered D is down on the picks 1 to 12, and that lettered E on the picks 13 to 24, continuous traverse across the open spaces being made at these places. Thus, an opaque figure, with a very steppy outline, is formed on an open ground texture. Each single end is retained about the centre of an open space by being drawn about equally in opposite direction by two whip threads.

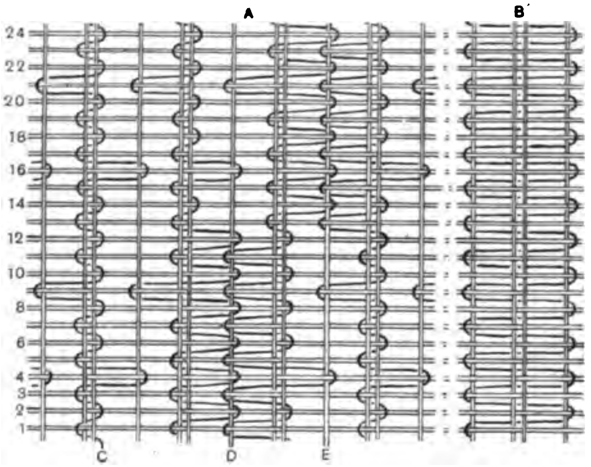

Fig. 349.

In forming the lace-like figure the needle bar simply requires to be traversed to left and to right in regular order, as illustrated by diagram B in Fig. 349. This may be accomplished by providing the proper width of slot in a *stationary* wheel, within which the peck, connected to the shifter frame, is moved to and fro. Indeed, the example illustrates a system of lappet weaving in which the wheel may be dispensed with so long as suitable means are provided to determine the regular to-and-fro movement of the shifter frame. In the stripe shown in Fig. 348 there are 14 single ends which work differently from each other, and the ground of the cloth is plain; therefore, a shedding motion of at least 16 shafts capacity is required. The chief difficulties in producing the style are in the tensioning and creeling of the different threads, and in keeping the shedding in correct time with the to-and-fro movements of the needle bar.

Patterns produced by varying the Order of Lifting the Needle Bars.—The diagram given at C in Fig. 350 illustrates a special style of lappet ornamentation in which, as in the foregoing example, the whip threads are traversed regularly to right and left all the time. In this case, however, the whip threads are stitched on to an ordinary plain ground texture, and as many needle bars are required as there are different orders of working in the repeat of the design. The repeat of C contains ten whip threads, which, as shown by the numbers below, may be drafted on to seven bars. All the needle bars are simultaneously moved a fixed distance (four spaces in this example) from left to right and from right to left on succeeding picks, and each whip thread is confined to a definite area in a straight line of the cloth. The vertical movement of each bar, however, is under separate control from a dobby, and by suitably pegging the lattices the whip threads are lifted into the shed opening, or are left out of action according to the effect which it is desired to produce. Leaving a bar down necessarily prevents the threads carried by it from being bound into the cloth; and it is upon the principle of thus neutralising the lateral movement of the bars which regularly takes place that the style of pattern under notice is produced. In C the horizontal lines, which represent the picks, are shown passing over the whip threads where the latter are bound into the cloth—on the left on the odd picks, and on the right on the even picks. In the plan D in Fig. 350 the vertical spaces are numbered to correspond with the whip threads in C, and the marks on the squares show where the threads are bound

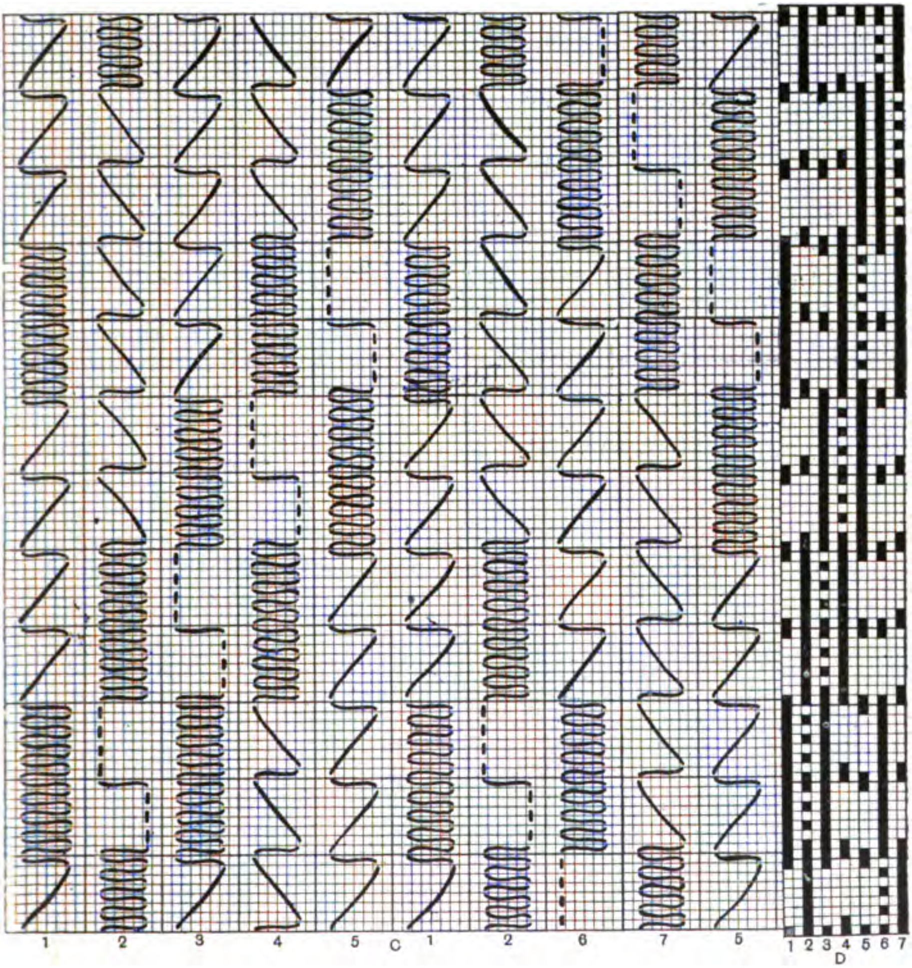

Fig. 350.

in—*i.e.*, where the needle bars are raised during weaving. A solid portion of whip figure is formed where a bar is lifted for a number of picks in succession, as shown by the thread 1 on the picks 8 to 25. By raising a bar on an odd pick, and leaving it out of action for a time before lifting it in on an even pick, the whip forms a diagonal line from left to right (on the face of the cloth), as shown by the thread number 1 on the picks 1 to 8. If, however, a bar is lifted on an even pick, and is then inactive before being lifted on an odd pick, a diagonal line from right to left is formed, as shown by the thread 4 on the picks 2 to 9. If a bar is lifted only on the even picks, it will form a straight line on the right, and if only on the odd picks a straight line on the left, as shown by the thread 2 on the picks 10 to 16, and 17 to 25 respectively. Each whip thread can thus be made to form two kinds of horizontal, vertical, and diagonal lines simply from the manner in which the bar is lifted. As it is only in a vertical direction that the bars require to be moved independently of each other they may be made thinner than is ordinarily the case, and a larger number can thus be placed in the space between the pin-bar and the reed. The system, combined with careful drafting of the whip threads on the bars, gives great scope for the production of comparatively elaborate effects which are different in character from the ordinary lappet styles.

Very many ingenious modifications of and additions to the Scotch lappet wheel loom have been made by different manufacturers, who purchase the loom in its standard form and adapt it to meet their special requirements.

CHAPTER XV

SWIVEL WEAVING AND DESIGNING

Purpose of Swivel Mechanism—Swivel Ornamentation and Embroidery compared—General Description of Swivel Mechanism—Relation of Pitch of Shuttles to Repeat of Jacquard. Detached Swivel Figures—Imitation Embroidery—Special Swivel Style—Figuring with two or more Swivel Wefts—Combination of Swivel and Ordinary Figures.—Production of Detached Figures in One Kind of Weft by Two Shuttles—All-over Swivel Figures. *Power Swivel Mechanisms*—All-over-Figuring Swivel Loom—Rack and Pinion Swivel Loom—Circular-Swivel Mechanism.

Purpose of Swivel Mechanism.—The term "swivel" was formerly applied to the type of loom in which several narrow fabrics, such as hat-bands, ribbons, tapes, etc., were independently formed alongside each other. In this machine a separate shuttle is employed for each fabric, but there is no fly shuttle, and the goods are now generally described as smallwares. In swivel weaving as at present understood, a number of small shuttles work in conjunction with an ordinary fly shuttle, the latter inserting a ground weft which forms with the warp a foundation cloth upon which the swivel shuttles produce figures in *extra weft*. The chief purpose of the swivel arrangement is to produce the ornament with the least possible waste of the extra yarn. Each figure, and in some cases each part of a figure, in a horizontal line of the cloth, is formed by a separate shuttle; the extra weft thus being introduced only where required, with little or no material extending between the figures on the reverse side of the cloth. In addition to the great saving of the extra, and usually costly, figuring yarn, the swivel method has the advantage over the ordinary system of extra weft figuring that each shuttle may control a distinct colour, while the figures have a richer and fuller appearance on account of the weft being thrown more prominently on to the surface. The addition of the swivel mechanism, however, makes the loom much more complex, consequently there is reduced speed and output. The cloths are woven wrong side up, and there is, therefore, the disadvantage that defects caused by broken ends more readily escape observation; but, on the other hand, weaving the cloth right side up would necessitate the bulk of the warp being raised on the swivel picks. Compared with lappet figuring, in which the floats of a thread cannot be stitched between the extremities, swivel figuring produces much neater effects, as any form of weave development can be applied to a figure.

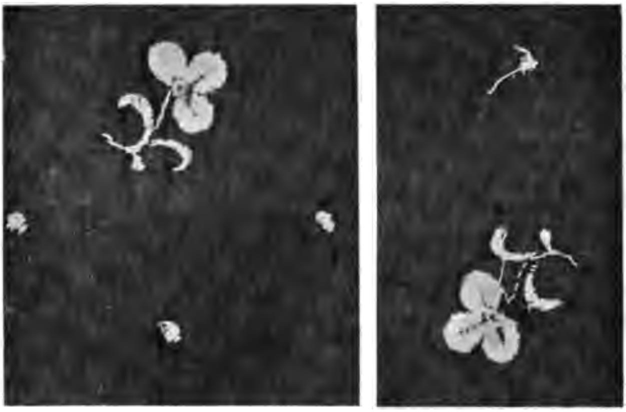

Fig. 351.

Comparison of Swivel Ornamentation and Embroidery.—Fabrics of a light transparent character are largely ornamented on this principle, but almost any structure and ground weave may be employed, and many rich and compact silk fabrics are spotted with swivel weft; while in some cases, in order to exhibit a particular part of a design prominently, a swivel figure is combined with a ground weft or warp figure. Effects are readily produced that appear and handle very similarly to styles in which the pattern is formed after weaving by embroidery; and in order that comparisons may be made, an illustration of an embroidered figure is given in Fig. 351, the face side of the cloth being shown on the left, and the underside on the right. The embroidery thread is wrapped round and round the threads of the foundation texture, and the figure shows as prominently, though with less neatness, on the reverse as on the right side of the fabric A distinguishing feature of the embroidered designs, which is illustrated in Fig. 352, is that the figuring threads may be inclined at any angle in the cloth. In swivel effects, however, the figuring threads are always traversed parallel with the weft threads of the foundation cloth, and at right angles to the warp threads.

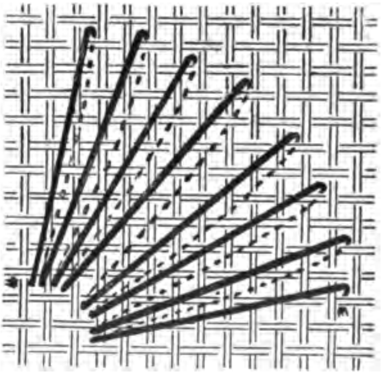

Fig. 352.

General Description of Swivel Mechanism.—A view of a power swivel loom, as made by Messrs. William Smith & Brothers, of Heywood, is given in Fig. 353, from which a general idea can be obtained of the machine, and of the cloth during weaving. The small shuttles are carried in holders supported in a frame which is mounted in front of the slay, and the cycle of operations, while the swivel figure is being formed, is briefly as follows:—After the insertion and beating up of each pick of ground weft in the ordinary manner, the ends are raised that the swivel weft has to pass under (or over on the face side); the frame that carries the swivel shuttles is lowered into the shed opening, each shuttle is moved from one holder to another through the shed made for it, and inserts a separate pick of weft, while the ordinary picking motion is thrown out of action; then the carrying frame is raised out of the way, and during the beating-up of the swivel picks the take-up motion is rendered inoperative. The motions are mainly controlled by the jacquard cards acting upon special hooks from which cord and lever connections are made to the respective parts of the swivel mechanism.

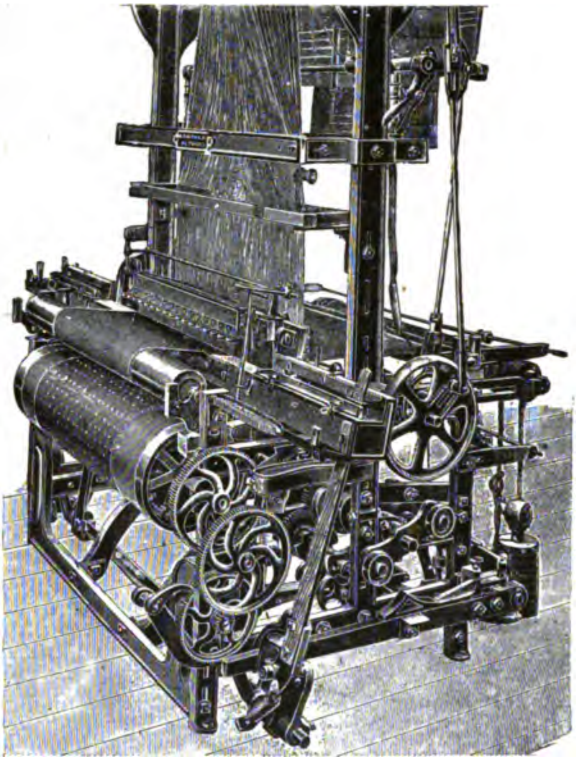

Fig. 353.

Relation of Pitch of Shuttles to Repeat of Jacquard.—The pitch of the shuttles should bear a definite relationship to the width of repeat that the jacquard will give; and there are three factors to take into account—viz., the pitch of the shuttles, the number of jacquard hooks tied up, and the number of harness cords per inch. For instance, a machine tied up to 600 hooks with 100 harness cords per inch will give a repeat of 6 inches in the reed. Therefore, if there are two swivel shuttles to each repeat, the pitch will be 3 inches; if three shuttles, 2 inches; if four shuttles, 1½ inches; and if six shuttles, 1 inch. Conversely, a given pitch of the shuttles will determine what sett of jacquard is suitable for a certain number of hooks tied up—*e.g.*, if the pitch is 3 inches, 100 ends per inch are suitable for a 300 tie giving one swivel shuttle to the repeat, and 64 ends per inch for a 384 tie giving two swivel shuttles to the repeat. Again, a given number of harness cords per inch will determine the number of hooks to tie up to suit a certain pitch of the shuttles. For example, with 96 harness cords per inch and the shuttles 2-inch pitch, the number of hooks tied up may be 192, 384, 576, etc., according to the number of swivel shuttles required to each repeat.

Detached Swivel Figures.—A typical swivel spot figure, on a plain foundation, is illustrated in Fig. 354, the face side of the cloth being shown on the left, and the reverse side on the right. The point-paper design (on a reduced scale) is given at A in Fig. 355; at B the face floats of the first figure are indicated with the swivel picks arranged alternately with the ground picks; while the corresponding flat view, shown at C, illustrates how a swivel thread is traversed in forming a figure. A complete spot is formed by one thread which is traversed alternately to right and to left on succeeding swivel picks; and as many swivel shuttles are employed as there are spots in a horizontal line of the cloth. Upon the completion of a line of spots, the swivel mechanism is thrown out of action until the commencement of the second line, when the carrying frame is situated so that the shuttles occupy the intermediate position, and the swivel threads are traversed again to right and to left in forming the figures which alternate with those in the first row. The mechanism is once more inoperative, until the shuttles are moved back to the original position in order to repeat the first line of figures; and, as shown by the dotted lines in A, Fig. 355, a thread floats loosely on the reverse side of the cloth from one spot to another. The floating threads are afterwards cut away, and this is the only waste of the swivel weft that is made, in addition to the ordinary weaving waste. It will be noted in A, Fig. 355, that on the first and last picks of each figure the swivel weft is firmly interwoven. This is in order that the free ends of the threads will not be liable to fray out of the foundation. As the cloth is woven wrong side up, the marks of the plan A indicate warp, and are, therefore, cut. A ground card is cut for each horizontal space in the full plan, hence there will be 64 ground and 50 figuring cards in the repeat of A,

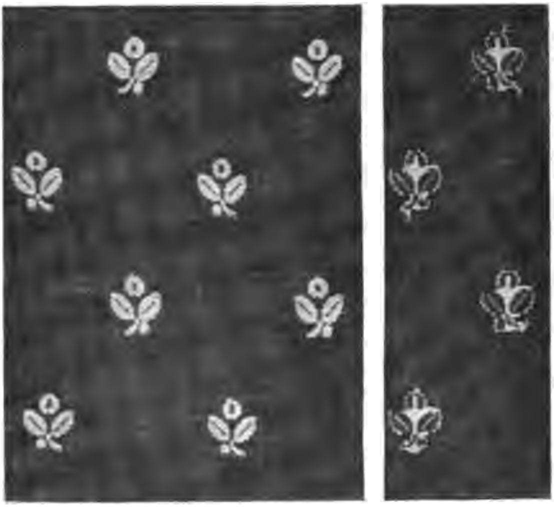

Fig. 354.

which will be arranged 1 ground card, 1 figuring card, for 25 times, and 7 ground cards.

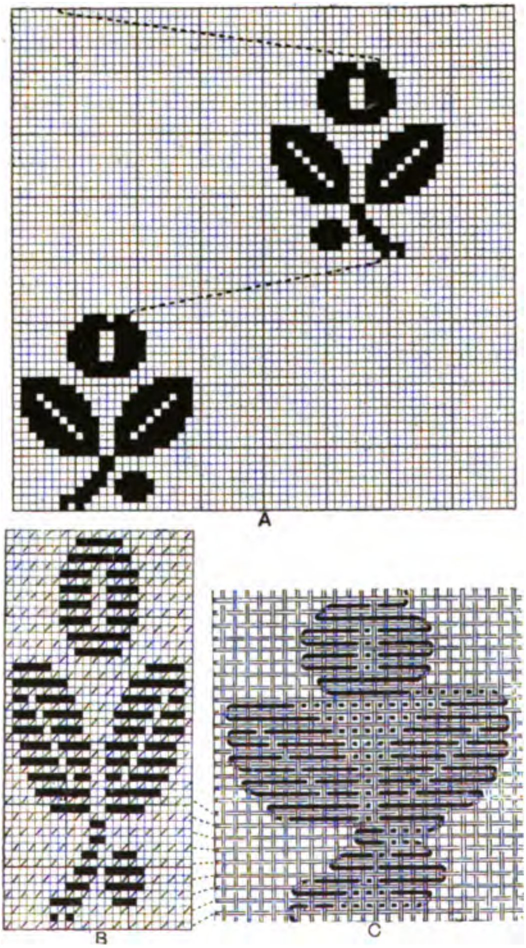

Fig. 355.

From the example given in Figs. 354 and 355 it will be seen that each swivel shuttle can be employed to ornament the cloth over a certain area in a longitudinal line. In forming spot figures in which the width of the repeat is equal to twice the pitch of the shuttles, it is necessary for all the shuttles in a frame to be traversed from one holder to another, but the weft is withdrawn only from those which are passed through a warp shed. In such a case an alternate arrangement of spots can be woven without the carrying frame being moved laterally, the odd shuttles forming one row of figures, and the even shuttles the figures that are intermediate.

Imitation of Embroidery.—The method of traversing the swivel threads illustrated in Figs. 354 and 355, while producing a prominent effect on the face side of the cloth, does not yield the same bulkiness of figure that embroidery does, because, on the reverse side, the floats of the threads occur only between the detached parts of the figure, as shown by the dots in C, Fig. 355. Fig. 356 shows on the left and right respectively the face and reverse side of a spotted fabric, in which the swivel figure more closely resembles an embroidered style. A reduced plan of the design on the right side of the cloth is given at D in Fig. 357; at E the swivel floats of a spot are indicated alternately with the ground picks; F shows the form of a spot on the underside; while G corresponds with F, with the ground picks included. The way in which a figuring thread is traversed in forming a spot is illustrated at H, in which it will be seen that the moves are always to the right on the face side, and to the left (indicated by dotted lines) on the reverse side. In this case the swivel shuttles, after having been passed through the shed in one direction, are moved in the reverse direction about the time that a ground pick is inserted, and while the carrying-frame is raised clear of the warp. Each figuring thread thus passes round and round the warp threads; but while it is possible to interweave the threads in any required order on the face side of the cloth, the floats on the reverse side cannot be bound in in any way. This method, while giving bulk to the figure, necessarily consumes more swivel weft than the system illustrated in Figs. 354 and 355.

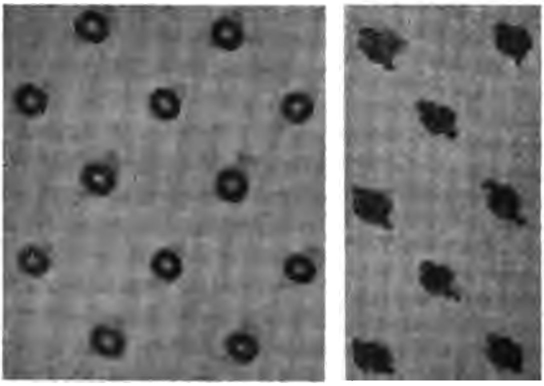
Fig. 356.

The two methods of traversing the figuring threads are sometimes combined in the same design as, for instance, in such styles as the example given in Fig. 358, in which waved vertical lines of figure are combined with a small spot effect. In order to give greater prominence and an embroidered appearance to the spots, in each horizontal line where the spots occur, all the figuring threads are traversed in the manner illustrated in Figs. 356 and 357; whereas on the picks between the spots, where the waved figure only is formed, the traversing is as shown in Figs. 354 and 355.

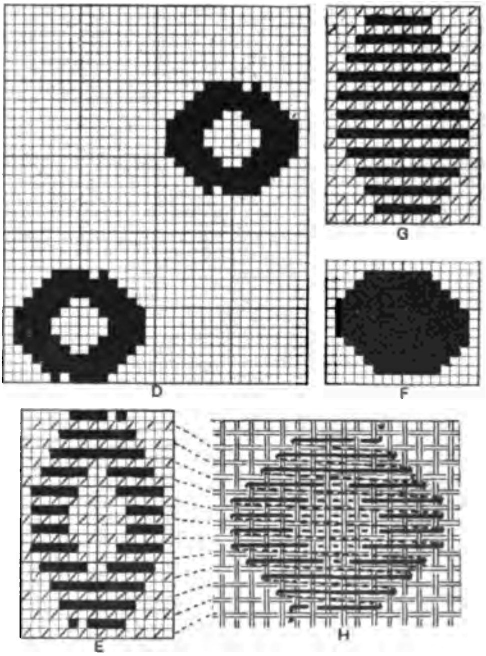

Fig. 357.

Special Swivel Style.—In most cases the swivel picks are introduced alternately with the ground picks, but other orders of wefting are readily arranged for, and an example is given in Fig. 359, in which there are six ground picks to each swivel pick. The upper portion of the figure shows the face, and the lower portion the reverse side, of the cloth. Each zig-zag line of figure is formed by one swivel thread which is stitched into the cloth by means of extra warp threads that are of the same colour as the figuring thread. This arrangement is in order that the swivel interweaving will form solid lines of colour on a ground of a contrasting colour. Another feature of the style is that the cloth is woven right side up. In the plan given in Fig. 360, which illustrates the principle of construction, all the marks represent weft float; the full squares show where the swivel weft floats on the surface, the diagonal strokes indicate a 2-and-2 twill foundation. while the crosses indicate where the extra warp threads are on the underside. The vertical floats of the swivel weft are obtained by the shuttles being held above the line of the shed while each series of six ground picks is inserted. Only five figuring and four ground healds are required, and the example is illustrative of how good swivel effects may be obtained in dobby shedding.

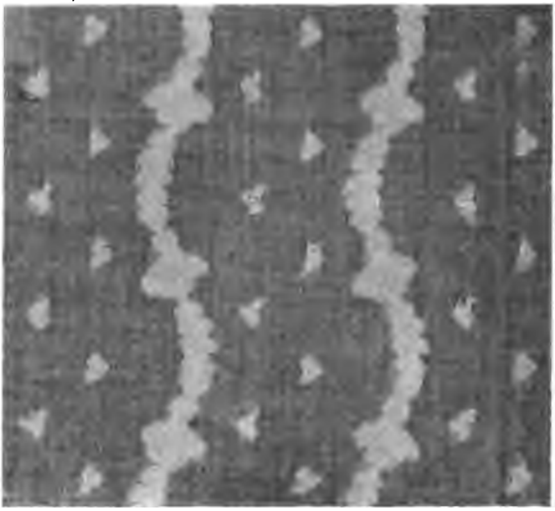

Fig. 358.

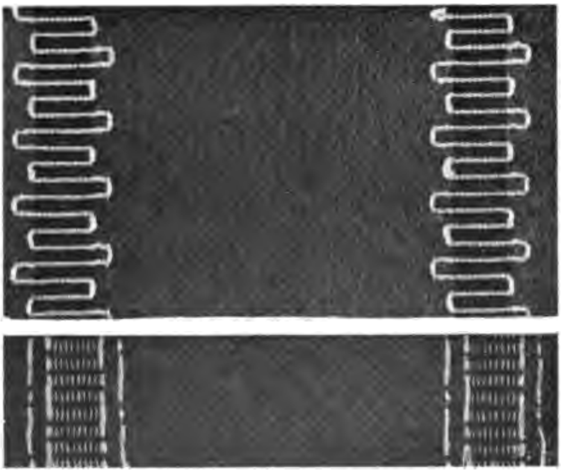

Fig. 359.

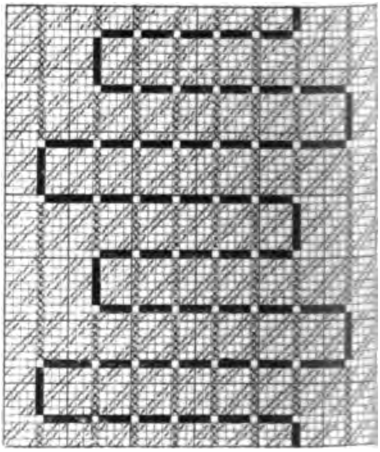

Fig. 360.

Figuring with two or more Swivel Wefts.—Some types of swivel looms are constructed with only one series of swivel shuttles, and not more than one kind of swivel weft can be inserted at a place. Other looms are provided with two or more "decks" or "banks" of shuttles which enable a figure to be formed by two or more colours in combination. More than three colours, however, are rarely employed—particularly in power swivel looms—on account of the increase in the complexity of the mechanism that each additional series of shuttles necessitates. An illustration of a simple spot formed in two colours is given in Fig. 362. A in Fig. 361 shows how a figure is indicated upon design paper,

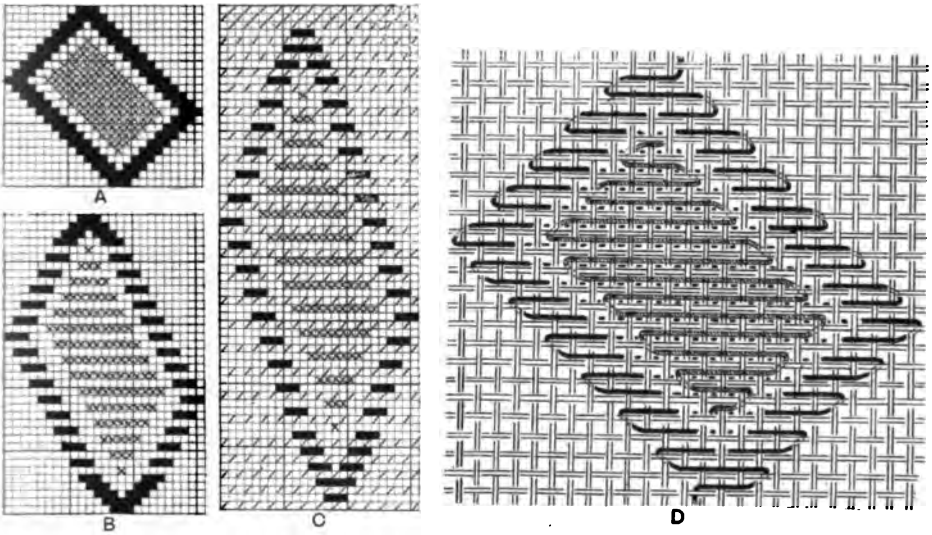

Fig. 361.

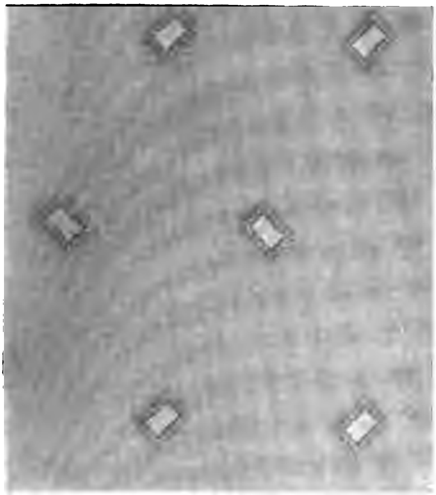

Fig. 362.

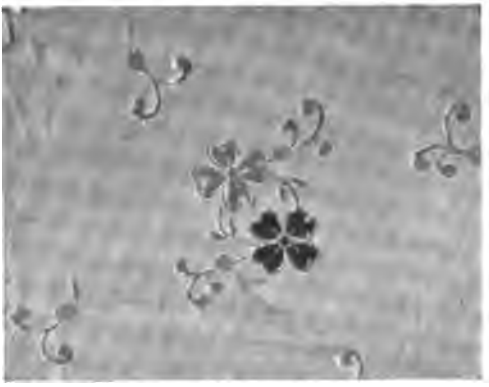

Fig. 363.

the different marks representing the different colours; at B the order in which the swivel figuring cards are cut is indicated; C illustrates the complete arrangement of the picks which compose one figure, while at D the corresponding flat view of the structure is given. When both figuring colours are inserted the two banks of swivel shuttles are operated in succession (holes being

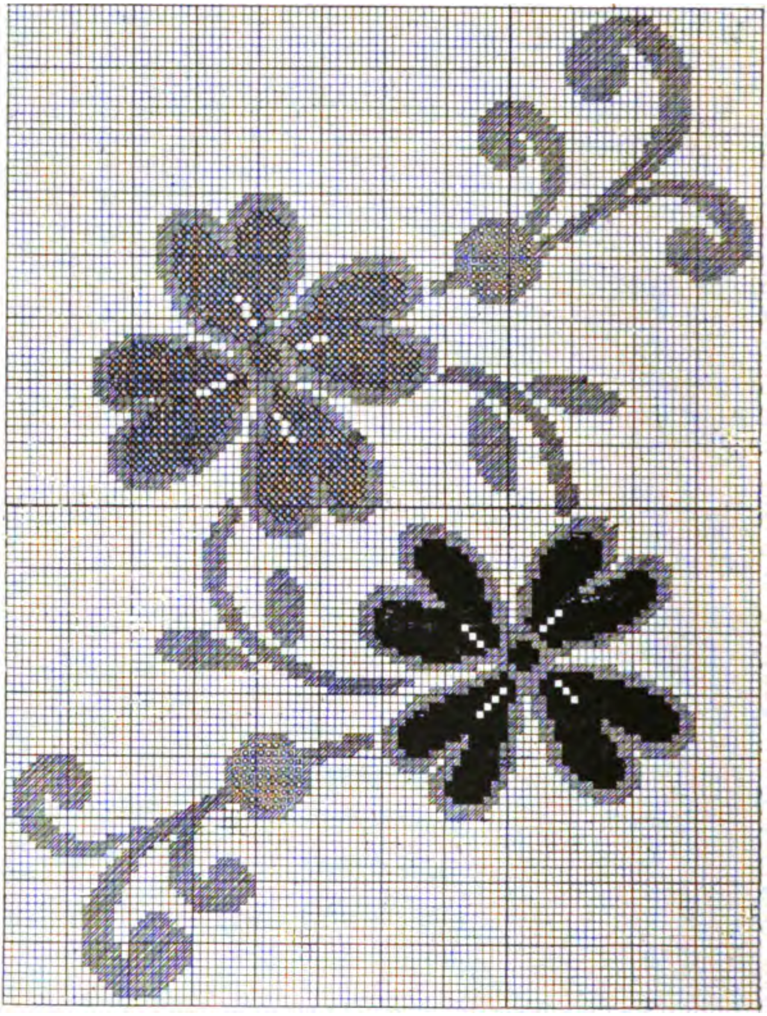

Fig. 364.

cut opposite the controlling needles in the respective cards), and there are two swivel picks to each ground pick. The order of arranging the cards for the example is as follows:—1 ground card, 1 first swivel card for 4 times; 1 ground card, 1 first swivel card, 1 second swivel card for 15 times; 1 ground card, 1 first swivel card for 4 times; followed by the required number of ground cards between the figures. After one row of figures has been formed, both series of shuttles are moved together to the position where the intermediate figures are produced. The swivel weft, which forms the outline of a figure, floats on the back below the central spot produced by the second colour of weft.

Combination of Swivel and Ordinary Figures.—Fig. 363 shows a swivel figure in two colours which is combined with and surrounded by a figure formed of the ground weft, and there are also spots produced by floating the warp. A corresponding sectional plan is given in Fig. 364, in which the shaded squares represent the ground weft figure, and the circles the warp figure; while the solid marks indicate the floats formed by one swivel weft, and the crosses those formed by the other swivel weft. All the marks are cut except the circles, the ground weft figure being cut on the ground cards while the ground weave is continued under the swivel figure. A ground card is required for each horizontal space, and a swivel card where the solid marks and the crosses are indicated; but in this case one swivel colour follows the other, hence there are never two swivel cards to a ground card. The complete arrangement of the cards for the plan, shown in Fig. 364, is as follows:—26 ground cards; 1 ground card, 1 first swivel card for 35 times; 1 ground card; 1 ground card, 1 second swivel card for 40 times; and 26 ground cards.

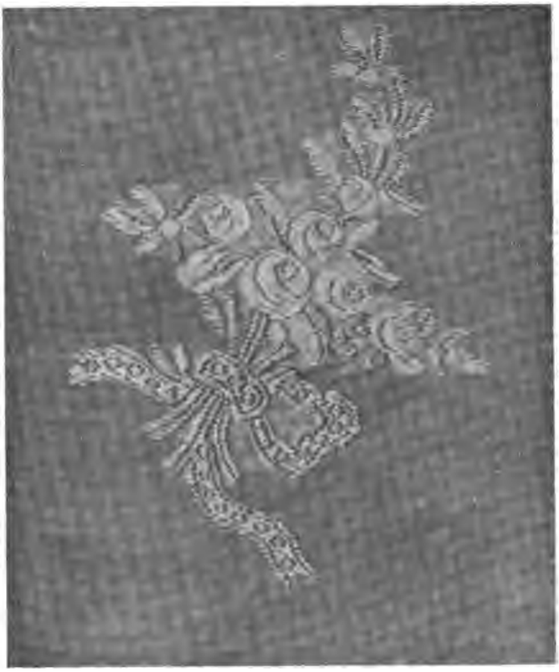

Fig. 365.

A two-colour swivel figure is given in Fig. 365, which is much larger and more elaborate in character than any of the preceding examples, and illustrates the diversity and intricacy of interlacing that can be obtained in swivel weaving. The ground yarns are not used in forming the effect, but both colours of swivel weft are introduced throughout the figure, therefore the form is painted in solid in two colours on design paper in the manner illustrated at A in Fig. 362, and two figuring cards are cut from each horizontal line of spaces. The complete figure is formed by one thread of each colour, and is a combination of stems, leaves, and flowers which are more or less detached from each other; and the foundation texture is a light gauze. As the swivel threads float on the underside between the separate parts of the figure, they are visible from the face side on account of the transparency of the foundation, and the opaque background thus formed detracts from the clearness and precision of the figure.

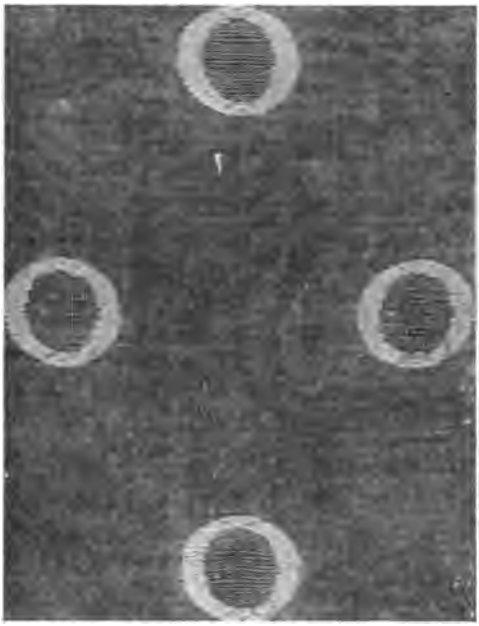

Fig. 366

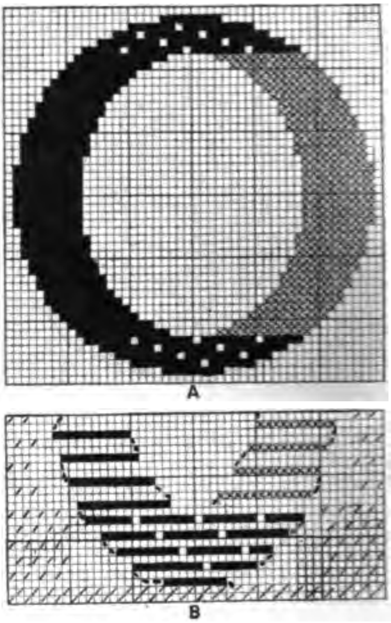

Fig. 367.

Production of Detached Figures in One Kind of Weft by Two Shuttles.— In order to avoid the defect described in the preceding paragraph, sometimes two banks of swivels are employed when only one kind of weft is used for figuring, and an example is given in Fig. 366 which shows a circular spot with an open-work centre formed on a thin muslin foundation. A representation of one figure is given on point-paper at A in Fig. 367, which shows that the top, bottom, and one side of a spot are formed by one shuttle, and the other side by a second shuttle. Where the open centre of the figure is formed, after each ground pick, the two series of shuttles are operated in turn in succeeding sheds, one shuttle forming one side of the spot, and the other shuttle the other side, with the result that there is no weft stretching between on the underside. B in Fig. 367 shows the full plan of the first 10 picks of A (except that the ground weave is not inserted under the figure), and the manner in which the threads are traversed by the different shuttles is indicated.

The top and bottom of each circular spot in the foregoing example are formed by one shuttle only, in order that the output will not be curtailed by the second series of shuttles being brought into action when not absolutely necessary. In Fig. 368 a similar form of spot, with an open centre, is illustrated; but in this case, as shown by the plan of one spot given at C in Fig. 369, each entire half of a figure is formed by a separate shuttle. Other forms of figures, consisting of two detached parts, can, of course, be formed in one kind of weft in this principle. A double-decked swivel-loom may be employed, the two series of shuttles being operated in succession on different sheds; but in another type of loom, which is illustrated in Figs. 375, 376, and 377, only one bank of shuttles is employed, all of which are operated at the same time. In the latter case a swivel shed is formed alternately with a ground shed, as indicated at D in Fig. 369, which shows the full plan of the first 22 picks of C.

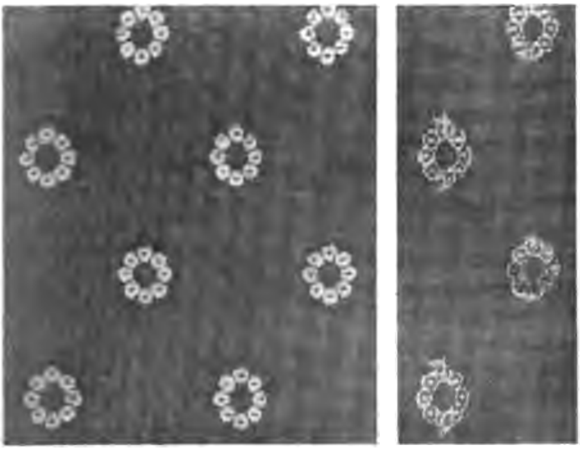

Fig. 368.

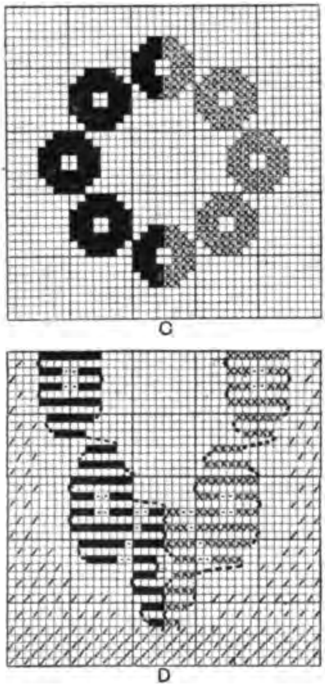

Fig. 369.

All-over Swivel Figures.—A limitation in certain types of swivel looms is, that some distance in a horizontal direction must separate the figures, in order that there will be space for the shuttle-holders to drop in between the groups of ends that are lifted. The minimum distance between the figures varies in different classes of swivel mechanisms, modifying factors being the size of the shuttle, the way in which the shuttles are held, and the space across which the threads have to be traversed. Such looms can only introduce the swivel weft to form spots or stripes, as in the examples that have been illustrated. There are other types of swivels, however, which (in a further development of the principles illustrated in Figs. 366 to 369) are so constructed that it is possible to distribute the ornament over the whole of the surface of the cloth, and either detached figures or all-over designs in one kind of weft can be produced. Illustrations of all-over designs are given in Figs. 370 and 372, and the corresponding sectional plans in Figs. 371 and 373. The different marks in the plans divide the figures into longitudinal sections, each of which is formed by a separate shuttle; and from a comparison of the two examples it will be seen that different methods of production are employed. Fig. 370 shows a hand-loom style in which four separate swivel shuttles are employed in forming each repeat of the design. The odd and even shuttles are in different series, and the two banks are operated in turn after each ground pick. Therefore, each horizontal space in Fig. 371 represents a ground card and two figuring cards, the full squares being cut on one of the latter, and the shaded squares on the other. The odd shuttles are lowered into the shed in the space where the figure is formed by the even shuttles, and *vice versa;* the portions of figure produced by one bank being far enough apart to allow the shuttles of the other bank to drop in between the groups of threads that are raised.

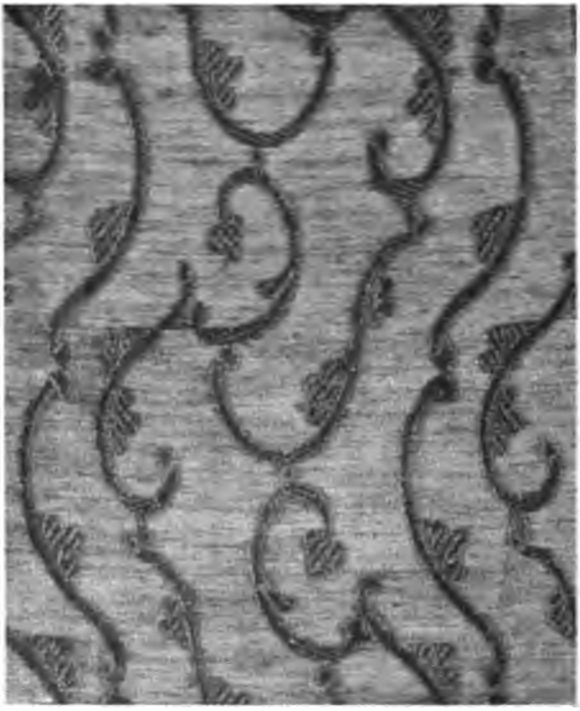

Fig. 370.

In Figs. 370 and 371 each shuttle at different times traverses a comparatively large number of threads, and in some places threads which are traversed by one shuttle in one portion of the design are traversed by another shuttle in another portion. On the other hand, in the example illustrated in Figs. 372 and 373, which is a power-loom style (Fig. 372 showing the face and reverse sides of the cloth on the left and right respectively), each shuttle is confined to a definite longitudinal area of the cloth. The pitch of the shuttles is about ½ inch, and 12 shuttles are employed in forming a repeat of the design, each figuring exactly over the width of 32 ends, as shown in Fig. 373. In this case only one swivel shed is formed

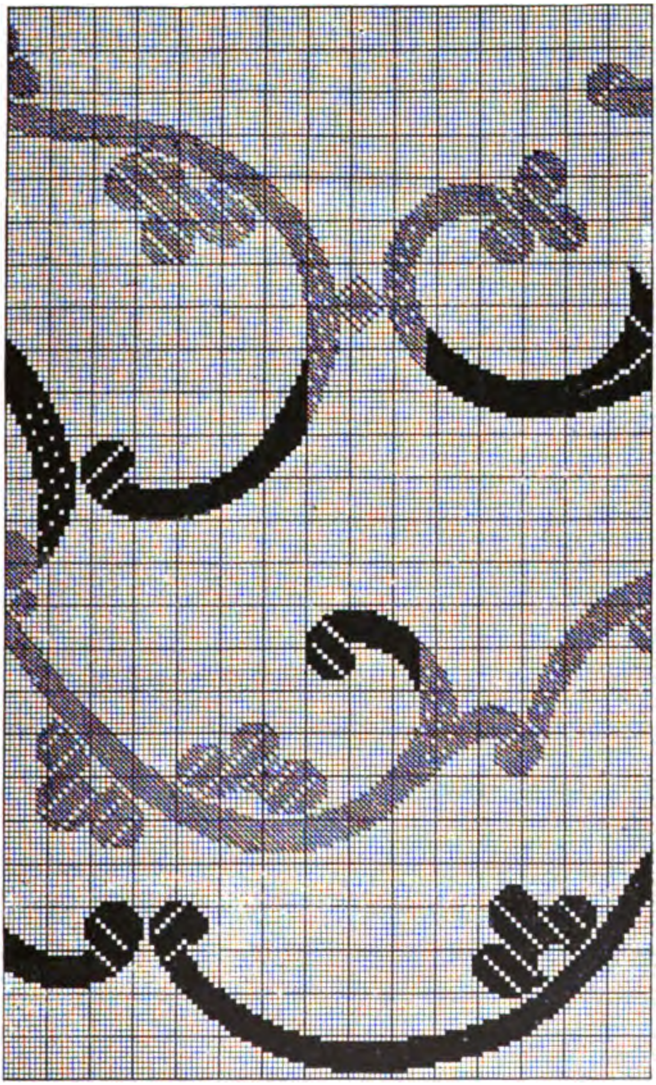

Fig. 371.

to each ground shed; therefore, each horizontal space in the plan represents a ground card and a figuring card, all the marks of the design being cut on the latter. The parts of the figure are joined up with perfect accuracy, one thread completing its interweaving where the next thread commences, as shown in the

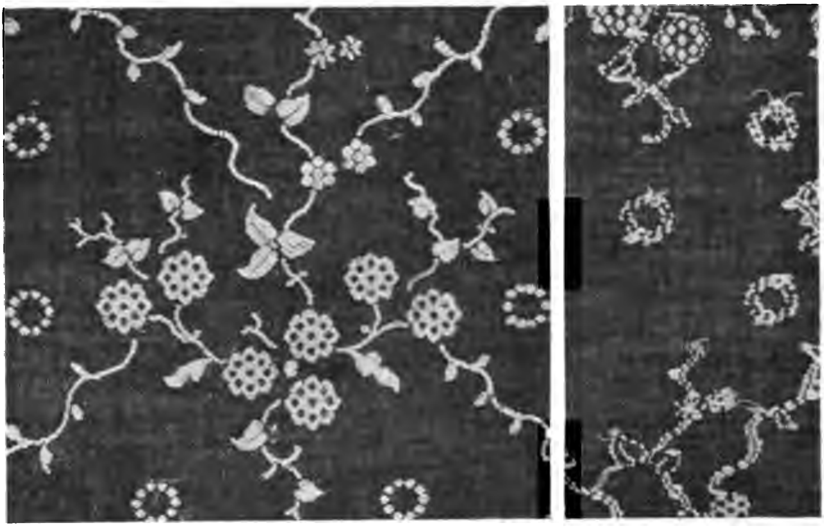

Fig. 372.

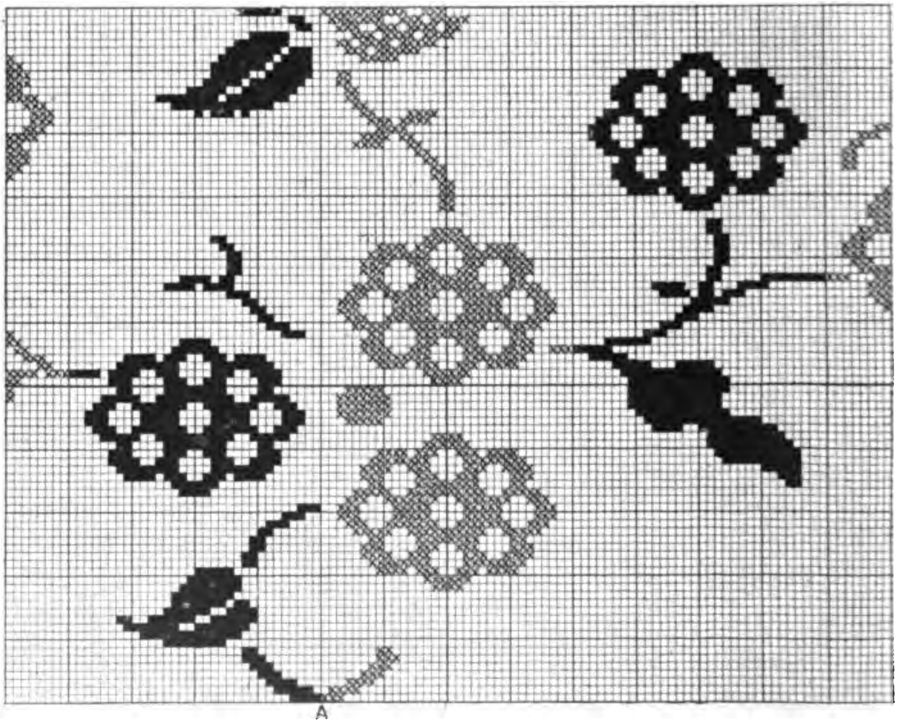

Fig. 373.

position lettered A in Fig. 373. In designing figures, however, the masses are generally so arranged that, while avoiding any tendency to stripiness, as few junctions as possible of the separate threads need to be made. When a transparent ground effect is required between two detached parts of the figure, it is necessary for the two portions to be formed by separate shuttles; thus, in Fig. 372 one side of each open spot is formed by one shuttle, and the other side by another shuttle. In the production of spot figures on this principle a lateral movement of the swivel-carrying frame is not necessary, since every portion of the width of the cloth is within the traverse of one or other shuttle, while if no ends are lifted in the line of traverse of a thread no figure is formed.

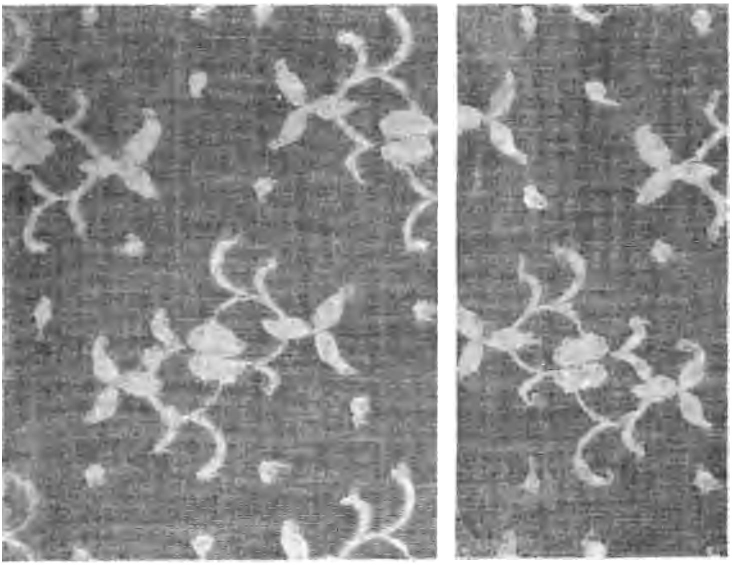

Fig. 374.

In Fig. 372 the traverses of the swivel threads are alternately to left and to right on the surface, and there is very little weft floating on the reverse side, which has a bare and flat appearance. An imitation of embroidery can, however, be obtained in the all-over figured styles, and an illustration is given in Fig. 374, in which each swivel thread is floated across the figuring ends on the underside in the manner described in reference to Figs. 356 and 357 (p. 339). The figure on the reverse side of the cloth (shown on the right of Fig. 374) has a rough appearance, but it is quite as prominent as on the surface. The designing of the figure is not affected by the way in which the threads are traversed, the only difference being in cutting the cards opposite the needles which govern the movements of the shuttles.

POWER-LOOM SWIVEL MECHANISMS

All-over Figuring Swivel Loom.—A view of the type of swivel loom in which figures may be produced either over the whole of the surface of the cloth, as shown in Figs. 372 and 374, or in the form of detached spots, as shown in Fig. 368, is given in Fig. 375. This loom is made by Messrs. Crompton & Knowles, U.S.A., and the chief features to note in Fig. 375 are the parts and their connections at the top of the loom to which the jacquard cords are attached, and the position and shape of the minute shuttle-holders and shuttles in front of the going part.

The principal movements of the swivel mechanism are illustrated by the drawings in Fig. 376, while the details by which the movements are governed are shown in Fig. 377. The same letters are used throughout for the parts which correspond. The carrying frame A consists of a transverse bar to which are fastened by screws the swivel shuttle-holders B, each of which is in the form of a downwardly extending finger that is pointed and curved towards the reed at the lower end, as shown in the drawings Nos. 1 and 3 in Fig. 376. Each swivel shuttle C extends in a horizontal plane from a holder B, the two being so shaped that a lip on one fits into a groove in the other. The pitch of the shuttles is usually about ½ inch, and a small space separates the holders from one another, as shown in the drawings Nos. 4 and 5. The spools are held by the shuttles C in a position at right angles to the slay, and the threads pass from them through openings in the bottom

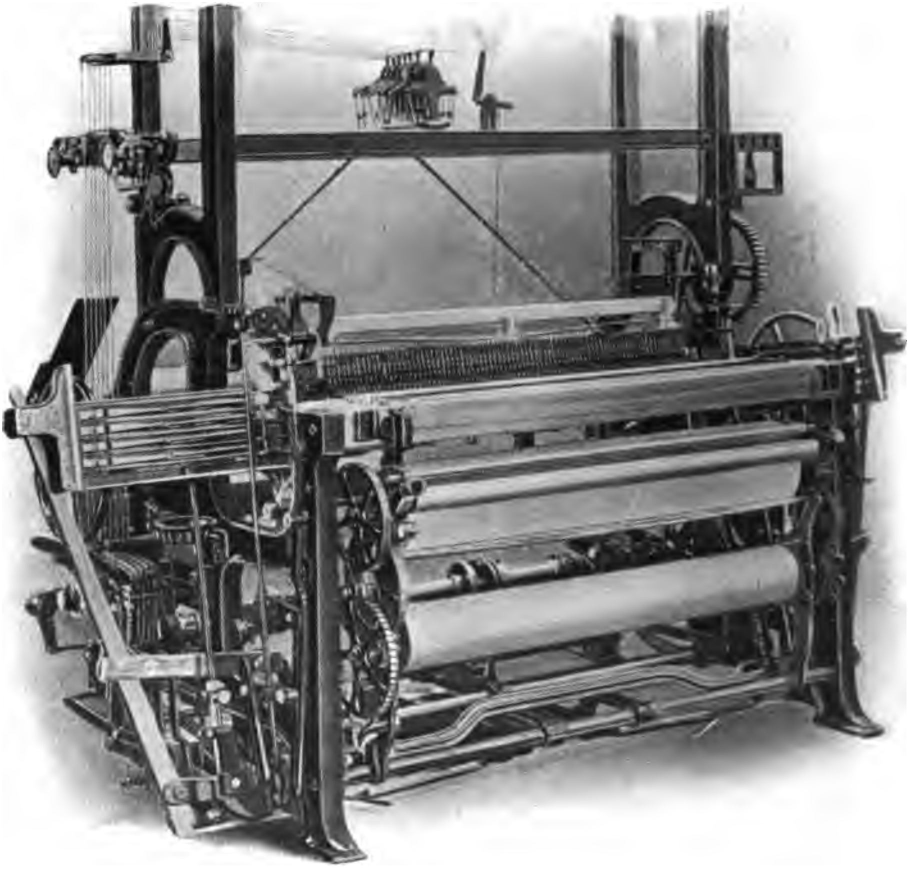
Fig. 375.

of the shuttles. A spindle extends through each spool, and in order to prevent the latter from over-running as the thread is withdrawn, it is tensioned by two spiral springs D placed upon the spindle, as shown in the drawing No. 1. A shuttle may be open on its upper side, as shown in the drawings Nos. 1 and 3, or it may be in the form shown at 2, in which the spool is supported in a removable metal carrier E which is held in two vertical grooves in the body of the shuttle. The advantage of the latter arrangement is that the tension on the spool can be properly regulated as it is placed in the carrier, so that no further adjustment is required when the carrier is placed in the shuttle.

In placing the shuttles C in the shed opening, as shown in No. 3, the carrying frame A is lowered, and the pointed ends of the shuttle-holders B, as they descend into the shed, divide the warp threads that are raised and push them in groups into the spaces between the holders. The shuttles are then moved transversely from one holder to another by means of the levers F (shown in the drawings Nos. 3, 4, and 5), the lower ends of which engage with the necks of the shuttles. Any warp threads that are raised by the jacquard will be passed under by one or other of the shuttles, and weft figures may be formed on the underside at any desired place across the entire width of the cloth. Where no threads are raised the shuttles simply pass from one holder to another without any swivel yarn being withdrawn from the spools.

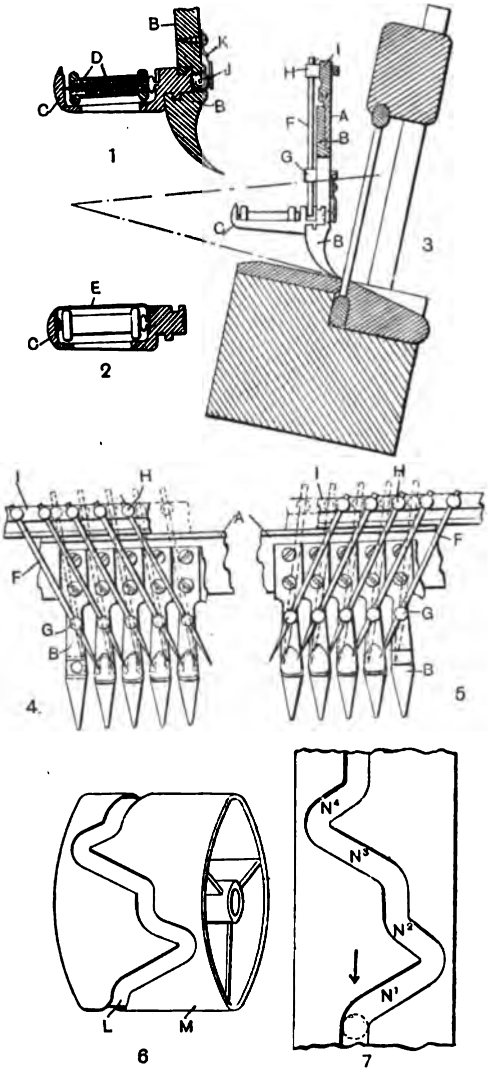

Fig. 376.

Each lever F is pivoted on a shuttle-holder B by a pin G, and its upper end passes loosely through a stud H, which is free to turn on its centre. The studs H are carried by a sliding bar I which is mounted on the upper grooved edge of the carrying frame A, in such a manner that it can be slid longitudinally, and transmit, by means of the levers F, the transverse movement to the shuttles. After a shuttle has completed its traverse, it is held firmly in position by a ball J (shown in the drawing No. 1), which is pressed into a depression at the rear of the shuttle by means of a spring K.

At the time of lowering and raising the carrying frame A, the levers F require to occupy one of the positions shown in dotted lines in the drawings Nos. 4 and 5, in order that they will not obstruct the warp threads ; while in traversing the shuttles the levers are moved from the dotted position shown in one drawing to the position shown in full lines in the other drawing. The complete round of movements of the levers F, during which two swivel picks are inserted, is as follows :—

1. From the dotted position shown in No. 4, to the full line position shown in No. 5.
2. From the full line position shown in No. 5, to the dotted position shown in No. 5.
3. From the dotted position shown in No. 5, to the full line position shown in No. 4.
4. From the full line position shown in No. 4, to the dotted position shown in No. 4.

The swivel shuttles are traversed to the left at the first movement, and to the right at the third movement. Between the second and third, and the fourth and first movements, the carrying frames is raised, and remains up while a ground pick is inserted ; the frame is then lowered. The movements are governed by a cam groove L cut in the periphery of a drum M (shown in the drawing No. 6), which is turned one-sixth of a revolution at each swivel pick. An anti-friction bowl N, carried at the end of a lever O (shown in the drawings Nos. 12 and 13 in Fig. 377), travels within the cam groove, and the drawing No. 7 in Fig. 376 shows in plan the portion of the groove by which the complete round of movements of the levers F is obtained ; the arrow indicates the direction of revolution. The first movement is obtained by the bowl travelling along the long portion of the groove marked N^1, while the short portion marked N^2 produces the second movement ; there is subsequently an intermission of the rotation of the drum during which the carrying frame is raised and again lowered. The third movement is produced by the long portion of the groove marked N^3, and the fourth movement by the short portion marked N^4, after which the drum is again at rest while the carrying frame is raised and lowered. The drum M is stationary all the time that no swivel weft is being inserted.

The mechanisms which govern the picking of the fly shuttle, raise and lower the carrying frame A, and give the longitudinal movement to the sliding bar I, are illustrated in Fig. 377. Certain hooks in the jacquard are employed for controlling the motions, and the drawings Nos. 8 and 9 (the latter on an enlarged scale) show the parts which communicate the movement from the jacquard to the loom. Cords P, from the jacquard hooks, are connected to two arms which form an extension from a cam Q (see drawing No. 9) fulcrumed on a stud R that passes through a horizontal slot in a rocking lever S. At the sides of the slot pins T are fixed to the lever S in a position to be engaged by the cam Q. The stud R is fixed to a bracket U on which the rocking lever S is pivoted at its lower end, and from the upper end of S a cord V passes either over a guide pulley or is connected to the upper arm of an angle lever W, as shown in No. 8. Lifting a cord P causes the cam Q to turn on the stud R and engage a pin T connected to the rocking lever S, the upper end of which, therefore, moves to the left if the right-hand cord P is raised, and to the right in the case of the left-hand cord. A lever, fulcrumed on the upper central part of the cam Q, serves, by means of the springs that are connected to it, to lock the cam in either position to which it is moved by the cords P.

The fly shuttle picking motion is on the slide principle, and the parts which throw the mechanism into and out of action are shown in the drawings Nos. 10 and 11 in Fig. 377. Two sliding rods *b* and *c* are connected at their inner ends to a lever *d* in such a manner that when the rod *b* is moved in one direction, the rod *c* is caused to move at the same time in the opposite direction. Each rod has secured to it a forked arm *e* which engages with the grooved hub of the casting that carries

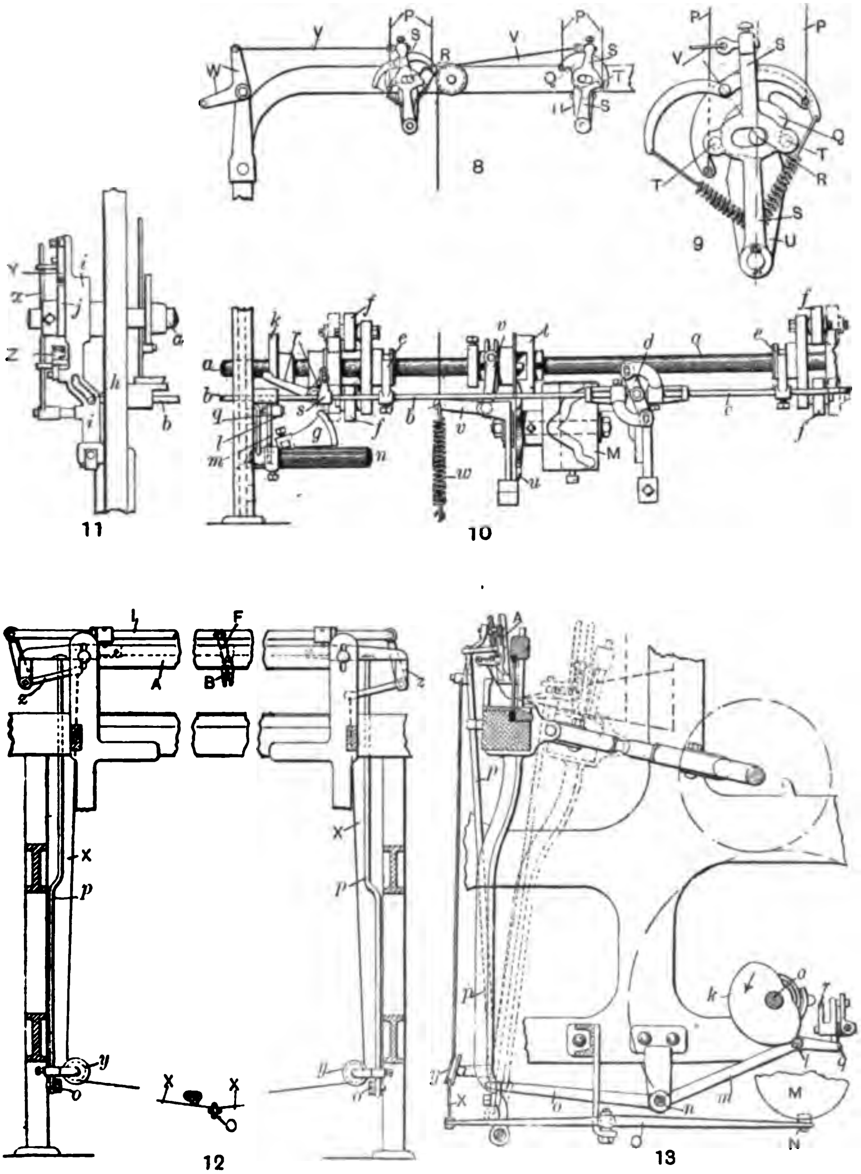

Fig. 377.

the picking rolls *f*, and according to the direction of the movement of the rod *b*, the picking rolls are slid along the bottom shaft *a* into or out of engagement with the picking shoes *g*. The arrangement by which the sliding movement is imparted to the rod *b* is shown in plan in the drawing No. 11. The rod *b* extends through the framing of the loom, and carries on its outer end a stud *h* which enters a diagonal slot in an arm *i*. A cord from the lower arm of the lever W (shown in the drawing No. 8) is attached to a lever *x*, the raising and lowering of which bring in turn two fingers Y and Z—connected to the arm *i*—in the path of a tappet *j* which is keyed on the low shaft *a*. The tappet *j*, in engaging a finger Y or Z, gives a longitudinal movement to the arm *i*, and by means of the slot moves the stud *h*, and thereby transmits the sliding movement to the rod *b*.

The carrying frame A is lowered into the shed opening, as shown by the dotted lines in the drawing No. 13, as the going part recedes from the cloth, and is raised out of the way during the forward movement of the slay. The vertical movement of the frame A is effected by a cam *k* (shown in the drawing No. 13) on the bottom shaft *a*, which engages an anti-friction bowl *l* carried at the rear end *m* of a lever that is fulcrumed on a rocking shaft *n*. The weight of the parts is sufficient to keep the bowl *l* in contact with the cam *k* (if necessary a spring may be used in addition), and as the cam revolves the shaft *n* is rocked and the forward end *o* of the lever lowered and raised. The shaft *n* extends the width of the loom, and at the opposite side there is another lever *o* fulcrumed on the shaft. Two upright rods *p* connect the extremities of the levers *o* with the ends of the carrying frame A (as shown in the drawings Nos. 12 and 13), which, therefore, at each swivel pick is lowered into the shed opening and is then raised. To each end of the lay an upright slotted stand is fixed in which the carrying frame slides up and down.

When the carrying frame is lowered for the insertion of a swivel pick, the ordinary picking motion is inoperative, and it is very necessary to avoid any possibility of the fly shuttle and the swivel shuttles coming in contact with each other. For this purpose the rear end of the lever *m* is extended, as shown at *q* in the drawing No. 13, and whenever the fly shuttle is operated the lower arm of an angle lever *r* is moved in contact with the upper side of the extension *q* in the following manner:—The sliding rod *b* carries a slotted arm *s* (shown in the drawing No. 10), and into the slot a stud, fixed to the upper arm of the angle lever *r*, projects. Therefore, when the rod *b* is moved to the left to bring the picking rolls *f* into position to engage the picking shoes *g* (as shown by the dotted lines in the drawing No. 10), the slotted arm *s* is also moved to the left, and the angle lever *r* is rocked so that its lower arm engages the extension *q* of the lever *m*. The latter is thus prevented from rising, and the carrying frame A from descending, so long as the fly shuttle mechanism is in operation.

The drum M, by which the longitudinal movement of the sliding bar I is governed, is rotated by a pin-wheel *t* (shown in the drawing No. 10) that engages a six-sided star-wheel *u* fixed on the hub of the drum. The pin-wheel *t* is keyed on a sleeve fixed to the bottom shaft *a*, and the upper forked arm of a lever *v* is provided with studs which extend into a groove in the boss of the pin-wheel. The lower arm of the lever *v* is connected by a spring *w* to the floor, and by a cord that passes upwards over a pulley to a rocking lever S. Lifting the left-hand jacquard cord P causes the pin-wheel *t* to engage with the star wheel *u*, and the drum M is turned one-sixth of a revolution. When the right-hand cord P is raised, the contraction of the spring *w* moves the pin wheel out of engagement with the star wheel, so that the drum remains stationary.

The bowl N, that travels in the cam groove of the drum M, is carried at the rear end of a lever O (shown in the drawing No. 13), which is centrally pivoted in such a manner that as the drum rotates the lever is caused to swing in a horizontal plane. Cords X (shown in the drawing No. 12) pass from the forward end of the lever O over guide pulleys *y* (which are mounted on brackets secured to the upright rods *p*) to the lower arms of the angle levers *z*, which are pivoted on brackets fixed to the carrying frame A. The horizontal movement of the lever O rocks the angle levers *z*, the upper arms of which convey a longitudinal movement to the sliding bar I, which, by means of the levers F, transmits the transverse motions to the shuttles in the manner previously described. In order to produce the appearance of embroidery in the cloth, as illustrated by the pattern in Fig. 374, the drum M is rotated one-sixth of a revolution on the ground pick between each pair of swivel picks.

Rack and Pinion Swivel Loom.—A type of power swivel loom is illustrated in Fig. 378 that is used in the production of spot figures which are placed some distance apart horizontally. This system of supporting and actuating the swivel shuttles is a development of the style that has been most commonly used in hand swivel weaving ; and in both hand and power looms it is chiefly this type of motion that has been adapted to the use of more than one bank of shuttles. The mechanism illustrated in Fig. 378, which corresponds with the view of a swivel loom given in Fig. 353 (p. 336), and is made by Messrs. William Smith & Brothers, Limited, is, however, only used for one series of shuttles, but the same principles apply when two or more series are employed.

Diagram No. 1 in Fig. 378 shows a front elevation, and No. 2 a section of the upper part of the mechanism from which a general idea of the principles of the motion can be obtained. The carrying frame A is recessed at its lower side between the shuttle-holders B, and the warp threads are raised for the swivel figuring in the spaces thus provided. The swivel shuttles C are held parallel with the slay, and the shuttle-holders B are made to correspond in width with the length of the shuttles. In order that the carrying frame may be lowered without obstruction into position for inserting the swivel weft, the distance between the figures must be at least equal to the width of the shuttle-holders. The width over which the swivel weft may be traversed at a place is limited to the space between the shuttle-holders, and this width must be not more than from $\frac{1}{3}$ to $\frac{1}{2}$ of the length of the shuttles, in order that the latter may be moved positively from one holder to another. The size of the shuttles and holders is varied according to requirements ; an increase in the space between the figures enables larger shuttles to be used, and the space between the shuttle-holders can then be proportionately increased. In wide repeats, therefore, broader figures can be introduced than in small repeats.

The upper portion of each shuttle-holder B is formed of the carrying frame A, a lip in the front of which fits into a groove formed in the upper face of the shuttles, but the lower portion is attached to a thin metal plate D which is fixed to the back of the frame A. A rack E is secured in a second groove formed in the rear of each shuttle, and a sliding bar F, which extends across the reed space in a groove in the frame A, has a leather rack G fixed to its underside. The rack G engages the teeth of the brass pinions H, which are fulcrumed on the pins I, and each pinion gears with a rack E on the upper side of a shuttle. The sliding bar F is caused to move alternately to right and left, and this movement, through the pinions H and racks E, is transmitted to the shuttles, which are moved from one holder B to another, and back again, on succeeding swivel picks. The number of shuttle-holders must be one in excess of the number of shuttles employed.

Diagram No. 3 in Fig. 378 shows a sectional elevation, and No. 4 a plan of the parts which govern the special motions of the loom. The swivel mechanism is brought into action, and the ordinary picking and weft motions at the same time are rendered inoperative by raising the weighted end of a lever J, through the medium of a cord L which is connected to a jacquard hook. The lever J is fulcrumed at K, and when raised by the jacquard—in which position it is shown—a bowl M, which is fulcrumed at an angle on a stud N, is brought against the cam face O of a disc P. The disc P is loose on the low shaft Q, but it is constantly rotated with the latter by means of a connection with a clutch R which is set-screwed on the shaft Q. No. 5 shows the form of the cam, disc, and clutch. By lifting the jacquard cord L the bowl M is lowered into contact with the cam face O of the disc P, and the cam O is so shaped that as it revolves P is caused to slide back along the low shaft against the pressure of a spring S. The end of the lever J is made sufficiently heavy to raise the bowl M out of contact with the cam O when the cord L is lowered by the jacquard; then the pressure of the spring S causes the disc P to slide forward on the shaft Q to its normal position (this is the sole purpose of the spring S). The disc P, which is constantly revolving with the low shaft Q, is retained in its normal position while the ground weft is inserted, and is moved back against the pressure of the spring on each swivel pick. A distinct feature of the mechanism is that the motions are controlled by one lever J, which is acted upon by a single jacquard hook.

The ordinary picking and weft motions are controlled by a cam T on the face of a star-wheel U, which is shown separately in No. 6. A bowl V, carried on the upper extremity of a vertical lever W, is kept in contact with the cam face T. The lever W is fulcrumed on a stud X, and is connected at its lower end with the rods Y and Z, the former of which is attached to the picking plate *a*, fulcrumed at *b* on the picking lever *c*; while the latter serves to control the weft fork mechanism. The disc P carries two pegs *d* (see No. 4), which, when P is in its normal position, engage and turn the star-wheel U one-eighth of a revolution at a time. The rotation of U, through the cam T and bowl V, causes the lever W to rock on its centre X and move the rods Y and Z; and the cam T is so shaped that when one picking plate *a* is brought into position to be engaged by a picking bowl, that at the other side is moved out of position. When the disc P is pressed back, the pegs *d* are moved out of engagement with the star-wheel, which, therefore, remains stationary while the swivel weft is inserted. The backward movement of P, through a small piece of mechanism (not shown in the drawings), causes both picking plates *a* to be moved out of engagement with the picking bowls. The arrangement makes it impossible for the fly shuttle to be operated at the time that the carrying frame is lowered.

The vertical movement of the carrying frame is effected by a cam *e* (which is on the opposite side of the disc P to the face cam O, and is shown in dotted lines in No. 3) and a spiral spring *i*. When the disc P is pressed back, the cam *e* engages a bowl *f* carried on a lever *g* which is fulcrumed on a stud *h*, and its action is to

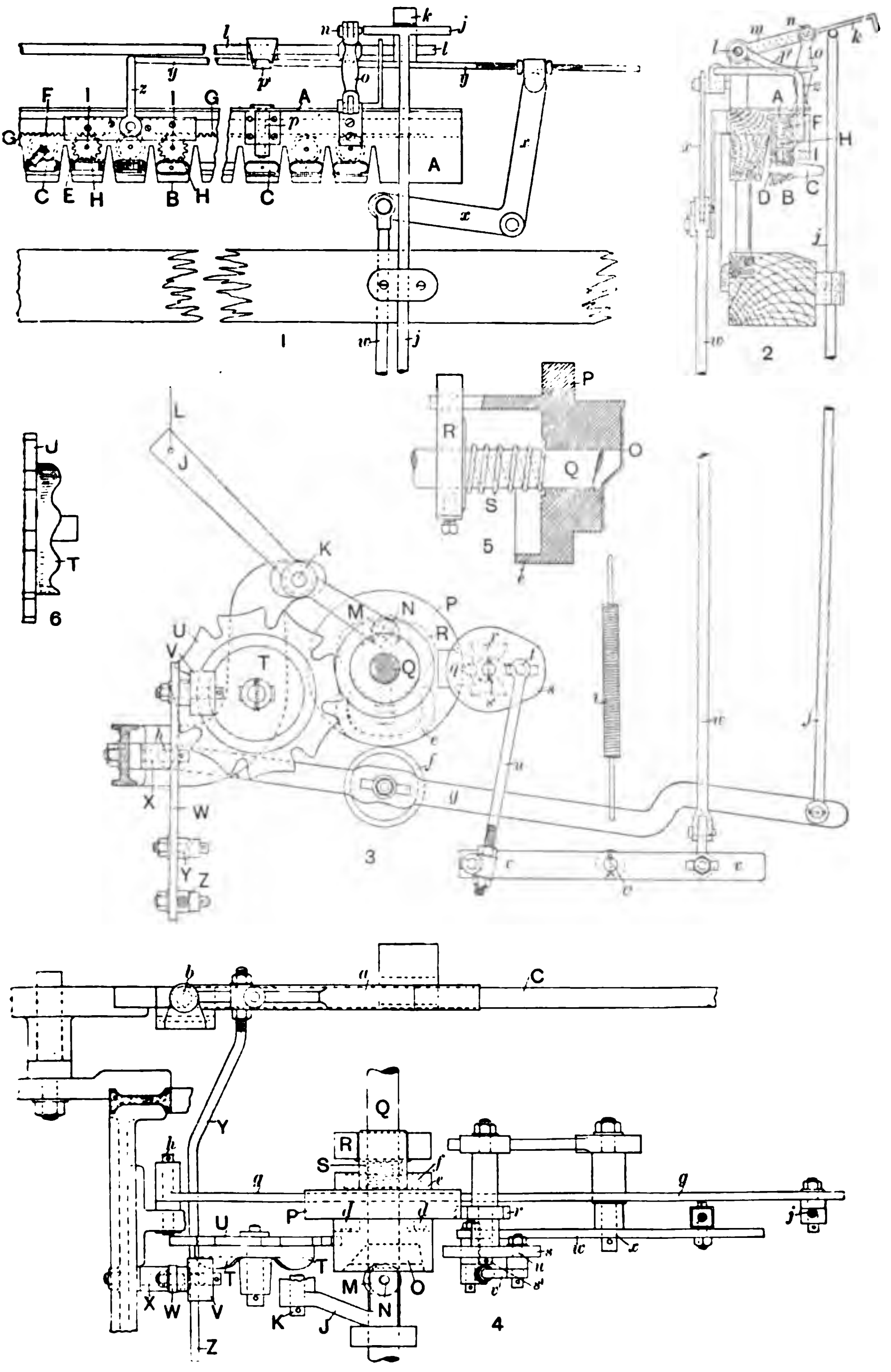
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Fig. 378.

depress the lever *g* against the tension of the spring *i*; while the purpose of the latter is to keep the bowl *f* in contact with the cam *e*, and to raise the lever *g* when the pressure of the cam is removed. A rod *j*, which is connected to the end of the lever *g*, has resting upon its upper extremity a lever *k* which is fulcrumed on a rocking shaft *l*. The shaft *l* extends across the reed space, and supports at each side a lever *m*, which carries a stud *n* on which the upper end of a pendant arm *o* is fulcrumed; while the lower end of the arm *o* is secured to the carrying frame A. The weight of the parts is sufficient to keep the lever *k* in contact with the end of the vertical rod *j*, so that when the lever *g* is depressed by the action of the cam *e* the carrying frame A is lowered into the shed opening. When the downward pressure of the cam *e* is removed, the contraction of the spring *i* causes the vertical rod *j* to push the lever *k* upwards, and the carrying frame is raised. During the rising and falling movement the frame is steadied at each side by a stud which enters a brass guide *p*. A lever p^1, which is fixed to the rocking shaft *l*, is placed directly over and rests upon each guide, and this lever can be adjusted so as to regulate the distance that the frame descends.

The transverse movement of the swivel shuttles is obtained as follows :—When the disc P is moved back, the teeth *q*, secured to P by a setscrew, are brought into the path of a star-wheel *r*, which is compounded with an eccentric plate *s*, as shown in drawings Nos. 3 and 4. The star-wheel *r* and the plate *s*, which are loose on a stud s^1, are turned one-half of a revolution; and the stud *t*, carried by the eccentric plate *s*, is moved from the bottom to the top on one swivel pick, and from the top to the bottom on the following swivel pick. The stud *t* is connected by the rod *u* to a lever *v*, which is fulcrumed at v^1, and the rotation of the eccentric *s* causes a vertical rod *w* to be alternately lowered and raised. The rod *w* is connected to the lower arm of a bell-crank lever *x*, to the upper arm of which a rod *y* is connected, while a pendant *z*, from the rod *y*, is secured through a slot in the front of the carrying frame with the sliding bar F. The falling and rising movement of the vertical rod *w* therefore transmits a horizontal motion to the sliding bar F, and the shuttles are caused to move from one holder to another, and back again, on succeeding swivel picks in the manner previously described.

A motion (not shown in Fig. 378) is provided at the driving side of the loom for moving the carrying frame horizontally, so that intermediate figures may be formed. A star-wheel is caused to turn when required by means of suitable connections from the jacquard, and on the boss of the star-wheel a chain barrel is secured which carries a cast-iron chain. This chain is composed of two heights of links, and above—in contact with it—there is a bowl which is supported by a lever fulcrumed at the back of the loom. A high link lifts the front end of the lever, and by means of suitable connections a sliding motion is transmitted to the carrying frame. The next rotation of the star-wheel will bring a small link under the bowl so that the lever will fall and cause the frame to slide in the opposite direction.

Circular-Swivel Mechanism.—A view of a third type of power swivel loom is given in Fig. 379, which, like the last example, is used in producing figures that are placed some distance apart horizontally. As full explanations have already been given of two motions, only certain special features are considered in this case. The loom is made by Schroers, of Krefeld, who have adopted the principle of the American dobby motion for obtaining the principal swivel movements, and for operating the boxing and picking. Cords from selected jacquard hooks are attached to levers at the top of the loom, and by means of other levers and cords, connections are made at the side of the loom to the vibrating levers of the American motion. By means of the jacquard the centre gear wheels are caused to engage

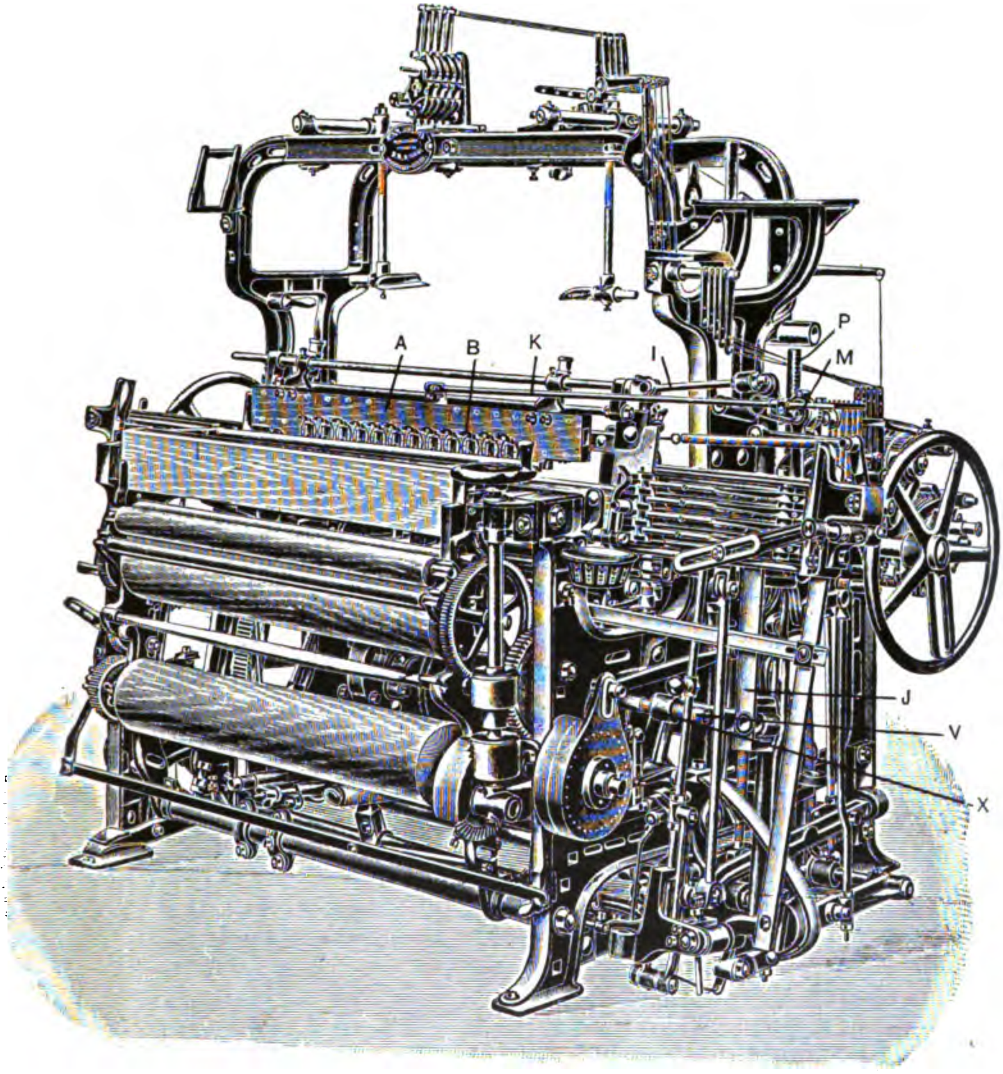


Fig. 379.

with the upper or lower segment wheels as required, and through the connecting bars, levers, etc., the motion is transmitted to the different parts.

Some of the distinctive features of the swivel motion are illustrated by the drawings given in Fig. 380, which correspond with the view shown in Fig. 379, except that the hand of the loom is different. The same letters are used in each case to indicate the several parts. The swivel shuttles C (shown in the drawings Nos. 1 and 2) are attached by small screws D to the front of the shuttle-holders B, each of which is circular in form and somewhat resembles a horseshoe. The shuttle-holders are contained in circular grooves formed in the carrying frame A, and when the holders are at rest their points are in line with the sides of the recesses that are provided in the lower side of the carrying frame. The warp threads are raised within the recesses, and after the carrying frame has been lowered the circular holders are caused to make a complete revolution. The small shuttles are carried entirely round by the holders, and each inserts a pick of swivel weft below the warp threads that are raised. The holders are rotated in opposite directions on succeeding swivel picks.

The movement is imparted to the swivel shuttles in a similar manner to the preceding example, by means of a longitudinal sliding bar F, the teeth on the lower side of which engage with pinions H. The shuttle-holders B are slotted at the rear so as to form a circular rack E into which the teeth of the pinions H gear, and the parts are so arranged that each pinion operates upon two shuttle-holders, while each holder is engaged by two pinions. The shuttles are thus rotated positively at a constant speed, as when the open space in a circle is opposite one pinion, the movement is continued by the next pinion. The form of the circular rack E is shown in the perspective view given in No. 2, which represents a circle partly revolved.

The carrying frame A is pivotally connected by means of a rod I (shown in No. 3 and in Fig. 379) with the upper end of a vertical rod J, which is fulcrumed at its lower end on a stud J^1 (see No. 4) that is connected to the rocking shaft. The sliding bar F is similarly connected by means of a rod K to a stud L, which is fixed in the slot of a lever M fulcrumed on a short shaft N. The rear end of the shaft N carries a rack wheel O, which is engaged by the teeth of a vertical rack P. The rack P is lowered and raised on alternate swivel picks, and a rotary motion —first in one direction and then in the other—is imparted to the shaft N, and thereby to the slotted lever M. The downward movement of the rack P moves the lever M in the direction indicated by the arrow in the drawing No. 3, and by means of the connecting-rod K a longitudinal movement is imparted to the sliding bar F. The direction of the motion is reversed on the next swivel pick by the upward movement of the rack P. The mechanism can be readily adapted to the formation of the embroidery type of figure in which the swivel weft is floated on both sides of the cloth, as it is only necessary for the circles to be rotated in the reverse direction on the ground picks while the carrying frame is raised clear of the shed.

An interesting method of traversing the carrying frame horizontally is illustrated in the drawings Nos. 4 and 5. Two cords Q from separate jacquard hooks are respectively attached to two levers R and S, the former of which is fulcrumed at R^1, and the latter at S^1. The levers are provided with studs on which are pivoted pendant hooks T, which are retained in engagement with the opposite sides of a peg wheel U by means of a small spring. The wheel U is fixed on the end of a shaft V which passes freely through a slot formed in the sword W. The shaft V is in the form of a worm for about one-half of its length, and this portion gears with the boss X of an arm Y which is connected by means of a stud Z with the vertical rod J. By suitably perforating the cards the shaft V may be rotated in either direction at any interval through the medium of the levers R and S, the pendant hooks T, and the peg wheel U. According to the direction in which the shaft V is turned, the rod J (which is fulcrumed at J^1) is moved to the left or to the right at its upper end, and through the rod I a similar horizontal movement is transmitted to the carrying frame. The distance that the frame is moved at each lift of a harness cord varies chiefly according to the pitch of the worm on the shaft V, which is generally arranged to impart a movement ranging from $\frac{1}{16}$ to $\frac{1}{8}$ inch.

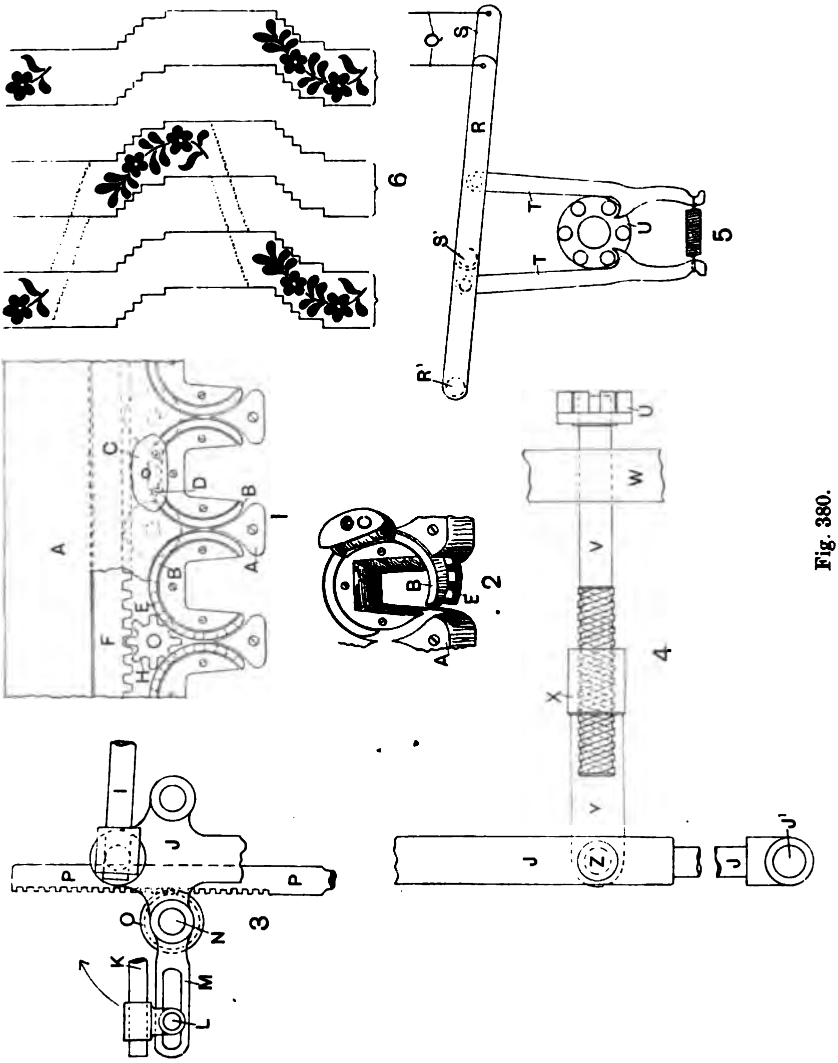


Fig. 380.

The chief advantage of this method of traversing the carrying frame is that it enables inclined figures to be formed which extend over a greater space than the width of the recesses in which the warp threads are raised. An illustration of the form of figure referred to is given in the diagram No. 6 in Fig. 380, in which the bracketed spaces between the vertical lines represent the width of the recesses. Each step of the vertical lines represents a horizontal movement of the carrying frame produced by one lift of a harness cord, and it will be seen that the space between the lines show a slight clearance over the width of the figure in every part. The design is arranged to coincide with the pitch of the circles shown in the drawing No. 1, the width of the repeat being equal to the space occupied by two circles. Each figure is represented as being formed by a separate shuttle, in which case, although all the circles will be rotated at the same time, the swivel yarn will be withdrawn from alternate shuttles only. The frame may, however, be traversed, as shown by the dotted lines, so that the same shuttles may be employed to form intermediate figures.

The diameter of the circles may be varied from 1 to 4 inches and upwards, and the horizontal space between the figures is generally rather less than half the pitch of the circles. As compared with the rack-and-pinion motion, in which the shuttles are moved longitudinally through the shed, the circular type gives greater scope for figuring, as the swivel spots can be formed with less space between; but there is the disadvantage that only one deck of shuttles can be employed. In both systems the swivel weft is withdrawn through the holes in the front of the shuttles, and an important factor, which is common to all types of swivels, is the proper tensioning of the weft so that the formation of curls at the sides of the figures will be avoided. A length of yarn is withdrawn from each shuttle every time the carrying frame is raised above the level of the shed, but by means of a spiral spring (placed on the spindle) upon which the spool exerts pressure as it revolves, the slack yarn is rewound on the spool as the frame descends. The spring is capable of rewinding a length of several inches, and there is, therefore, always a certain amount of tension on the yarn.

CHAPTER XVI

WEFT PILE FABRICS

Formation of Weft Pile. *Plain Velveteens*—Tabby or Plain-back Velveteens—Length of the Pile—Density of the Pile—Changing the Density of the Pile—Fastness of the Pile—Twill-back Velveteens—Designs which simplify the Cutting Operation. *Corded Velveteens*—Corded Velveteen Cutting—Corded Velveteens from Plain Velveteen Weaves—Particulars of Weft Pile Fabrics. *Weft Plushes. Figured Weft Pile Fabrics*—Figured Velveteens—Figured Cords. *Imitation Weft Pile Fabrics.*

In pile or plush fabrics a proportion of the threads—termed pile threads—project from a foundation texture and form a nap or pile on the surface. In some classes of the cloths the pile threads are cut and the surface of the cloth is then composed, where the pile is formed, of the free ends of the fibres which, in many cases, gives an appearance closely resembling fur. In other plush fabrics the pile threads are not cut, and the pile surface then consists of small loops or curls. The pile threads may be introduced as weft forming weft pile fabrics, in which the pile is invariably cut, or as warp forming warp pile fabrics, in some of which all the pile is cut, and in others all looped; while in certain textures a combination of cut and looped pile is produced.

Formation of Weft Pile.—Weft pile cloths are composed of only one series of warp threads, but the weft threads, so far as regards the system of interlacing, are in two series, namely, ground and pile. The ground picks interweave frequently with the warp so as to form a firm foundation, while the pile picks float somewhat loosely on the surface, and subsequently form the pile or nap.

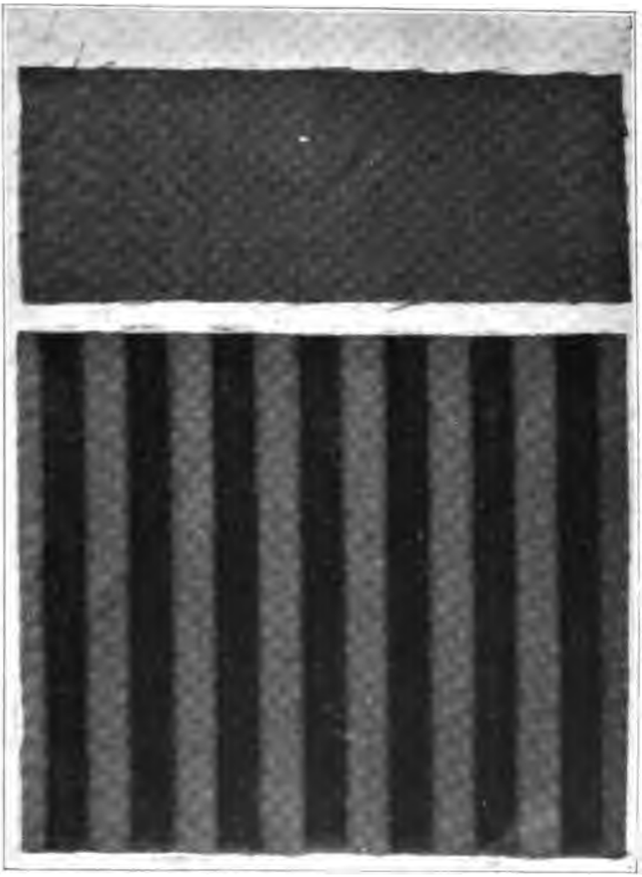


Fig. 381.

The textures are produced in the loom in the same manner as ordinary fabrics, and after weaving appear similar except that the surface of the cloth is densely crowded with the floating picks of weft which are to be cut to form the pile. The cloths on the underside show a plain rib or fine twill effect, according to the kind of ground weave that is employed. The appearance of a cloth in both the cut and the uncut condition is represented in the lower portion of Fig. 381. The dark sections show where the pile has been cut, but the light sections are uncut, and the latter indicate how the whole face of the cloth appears before the cutting operation. The example does not illustrate the usual appearance of a weft pile texture, as in this instance the idea has been to produce a variation from the ordinary type of cloth by forming stripes of pile ¼ inch wide with equal uncut spaces between. The upper portion of Fig. 381 represents the appearance of the under side of the cloth, the foundation weave being the 1-and-2 twill.

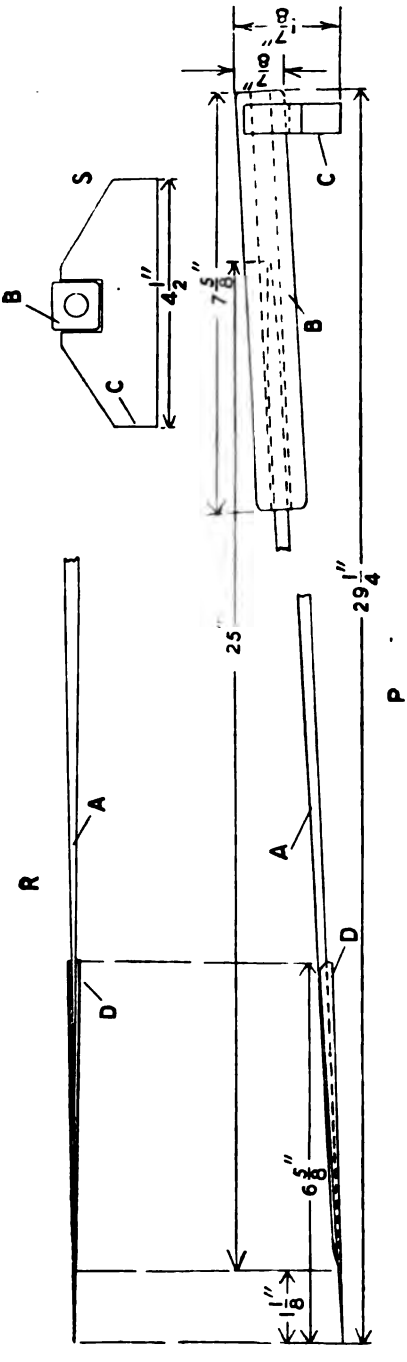


Fig. 382.

The formation of the pile is a part of the finishing process in which the floating pile picks are cut by means of a specially shaped knife—provided with a guide—which is run lengthwise of the cloth on its surface. The form of a cutting instrument is illustrated in Fig. 382, in which a front elevation is shown at P, an end view of the rear portion at S, and a plan of the cutting end at R. The dimensions indicated on the diagrams correspond with an example, but the size is varied according to requirements.

The knife A is a steel rod which, for the greater part of its length, is about ¼ inch square. The rear extremity is roughly pointed in order to facilitate its insertion in a removable wooden handle B, which has a circular hole bored throughout its length. The rear end of the knife is packed with cotton waste or other material in order to make it fit tightly within the circular hole, and it is pushed a greater or less distance within the handle in order to vary the length of the instrument. The handle is adjustably attached to a piece of wood C, which rests on the cloth and raises the rear end of the knife so that it is retained at a suitable angle during the operation of cutting. Usually the rest C is placed at the rear of the handle B, but if required it can be attached nearer the centre.

Towards the cutting end the knife is tapered, and for about 3 inches from the extremity it is made in the form of a narrow flat blade with a very sharp upper edge. The keenness of the blade is maintained by frequent grinding. This end of the knife is inserted in a removable metal sheath D, which terminates in a very fine point and acts as a guide. The upper edge of the blade rises above the edges of the sheath, and the object of the latter is to steady the thin blade, to guide it along the proper course, and to pass with its point under the floating picks and bring them into contact with the cutting edge.

Previous to the cutting operation the pile side of the cloth is passed in contact with the upper surface of a roller which revolves partly immersed in slaked lime contained in a suitable receptacle. A thin coating of lime paste is applied to the surface of the cloth, which is then dried by being passed in contact with hot cylinders. Subsequently, the cloth is further stiffened by the application of a coating of flour paste to the under side, and drying again follows. The purpose of the second application is to fix the pile weft threads in the cloth so that they will not be pulled out as the operation of cutting proceeds.

A length of the prepared cloth is stretched very tightly in a frame, and the operative runs the knife over its surface in the direction of the length. The finely pointed guide passes under the pile floats which are in line with its movement, and brings them into position for being cut by the blade. Successive traverses of the knife are made until the length under treatment is completed; then this portion is wound upon a beam and the next length of cloth operated upon. The process is repeated throughout the length of the piece. The cutting may be performed on short or long frames, the former taking from 1½ to 2 yards of cloth at a time, and the latter 9 or 10 yards.

The accurate joining of the cutting courses is a very important matter, as a defect will show at these places in the finished cloth if there is any irregularity. For this reason the long frame system is usually considered the better, because there are fewer places where the defect can occur. In the short frame system the operative cuts one cloth at a time, but in cutting long lengths two cloths, in adjacent frames, are treated. The operative walks between the two frames and cuts a course in one cloth while passing in one direction and a course in the other cloth on his return. The process is very tedious as from 700 to 1,000 longitudinal strokes of the knife may require to be made at each length in cutting across a width of 24 inches of cloth.

On the completion of the cutting operation the stiffening substances previously applied are removed by scouring, and the cloth is then dried. If any holes have been made during the cutting they are repaired by sewing the sides together with a fine needle. A wire is then laid on the cloth in line with the place, and a thread, similar to the weft, is stitched into the foundation and wrapped round and round the wire. After the withdrawal of the wire the loops are cut and the free ends evened by means of fine scissors.

A process of brushing follows the drying in which the pile surface is operated upon by flat brushes which work across the piece in opposite directions, and then by circular brushes. Afterwards superfluous fibre is removed by cropping or singeing; in the latter process the pile surface is passed lightly in contact with hot plates. In a good quality of cloth brushing and singeing may be repeated several times. After the singeing, the cloth is a brown or ecru colour, and if required to be dyed a light shade it is bleached.

In the dyeing process, the cloth is first treated in the ordinary manner, so that the foundation will be the proper shade, but in order to get a rich bloom in the pile this is followed by a process which more resembles printing. The pile side of the cloth is passed in contact with the upper edge of a finely engraved roller which revolves partly immersed in the dye solution. The amount carried up by the roller is regulated by a doctor knife. The colour is transferred to the pile, and as the cloth passes forward it is acted upon by revolving brushes which spread the dye over the surface. After drying, brushing again follows, and in some cases, the cloth is also briskly rubbed by hand with an emery covered piece of wood.

The fabrics are usually classified as plain velveteen and corded velveteen which are mostly made of cotton yarns. When the pile is very long, however, the term weft plush is used, and in this type the pile is frequently developed in woollen or worsted yarns.

PLAIN VELVETEENS

This class of velveteen has a perfectly uniform surface, the foundation texture being entirely covered by a short pile in which the projecting fibres are of equal length. In constructing designs for the fabrics the chief points to note are:—(1) The weaves that are used for the ground and pile respectively; and (2) the ratio of pile picks to ground picks. These factors, together with the ends and picks per inch of the cloth, influence the length, density, and fastness of the pile.

The foundation weaves mostly used are plain, 1-and-2 twill, and 2-and-2 twill, the last weave being employed for very heavy structures. The interlacing of the pile is almost invariably based either on the plain weave, a simple twill, a sateen, or a sateen derivative. The pile and ground picks may be arranged in any reasonable proportion, but generally a particular ratio is most suitable for a given weave.

Tabby or Plain-back Velveteens.—Examples A, B, C, D, and E in Fig. 383 are designs for standard velveteens, with the plain foundation weave. The latter is represented by the crosses, and the base weaves for the pile interlacings are shown at the left of the plans. In each design the number of pile picks to each ground pick is equal to the number of picks in the repeat of the pile base weave. This is a convenient ratio, but other proportions of pile to ground picks are quite easily arranged in the same weave.

A distinct feature to be noted in the designs is that the pile base weaves are indicated only on alternate ends; thus each plan is on twice as many ends as the base weave. Design A is arranged two pile picks to one ground pick, and the pile weave is based on the plain weave which yields a weft float of three. In a finely set cloth the pile from this design is short and poor, but if there are not many ends per inch, a fairly good result is obtained.

In design B, the pile weave is based on the 1-and-2 twill which yields a weft float of five, and there are three pile picks to each ground pick. This design produces a fine and rich effect, and is very extensively employed. Designs C and D are each arranged four pile picks to one ground pick, but whereas in design C the pile interlacing is based on the 1-and-3 twill, in design D it is based on the 4-sateen weave. Both of these yield a float of seven, and produce exactly similar results in the finished cloth. Design E is arranged five pile to one ground, and the base for the pile interlacing is 1-and-4 sateen, which gives a float of nine.

In order to produce a dense pile, a very large number of picks per inch are required to be inserted, the number varying from about 300 in 40's cotton weft for the design B in Fig. 383 to about 500 in 60's weft for the design E. There are two reasons why it is possible to insert such a large number of picks. First, the warp is held under great tension, and the ends lie almost straight in the cloth, which causes the picks to do most of the bending. This results in the foundation texture being formed on the weft rib principle, hence a comparatively large number of ground picks can be inserted. Second, the system in which the pile interlacing is arranged enables the pile picks to be beaten over one another, so that each row occupies not more than the space of one ground pick. Also, in the plain-back structures, all the pile picks go into the same shed as the first ground pick, but are in the opposite shed to the second ground pick. Therefore, so far as regards the space occupied by the picks, the structural effect of each design A to E in Fig. 383, is somewhat as represented at F—that is, the total number of picks in the repeat of each design go into the space of four picks, of which three are in the same shed.

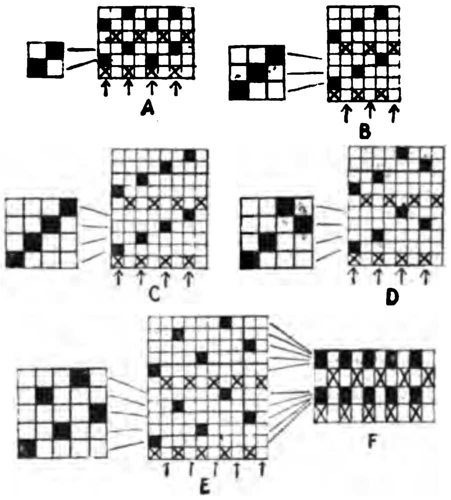


Fig. 383.

The diagrams given in Fig. 384, in which design G is similar to the plan B in Fig. 383, will enable various features of the velveteen structures to be noted. The flat view given at H, which corresponds with G, will serve to show somewhat how the pile picks crowd over each other in the cloth. This, however, is only a convenient representation of the structure, as in the actual fabric the ground picks are entirely concealed by the floating pile picks.

The purpose of binding in the pile picks only by the alternate ends (lettered A in H, Fig. 384) is to enable the cutting to be more easily and more quickly accomplished. This will be understood from an examination of the cross-sectional drawing given at I in Fig. 384, which represents how the picks 2, 3, 4, and 5 in the plan G interweave. Each pile float stands out furthest from the foundation cloth at its centre, and the guide of the cutting knife is so adjusted that only those floats are engaged whose centres are in line with the longitudinal movement of the knife. The method of binding the pile picks causes the centres of the floats (indicated by the arrows above diagram I) to occur only on alternate ends, therefore, only half as many longitudinal traverses of the knife are required as would be the case if the pile picks were bound in by every end.

An important feature, moreover, is that the alternate binding causes regular courses or races to be formed in the foundation texture, which are readily followed by the knife guide. The latter is so fine and flexible that when once its point is inserted in a race it will not readily leave it even though the operative's hand has a zig-zag movement along the surface of the cloth.

Arrows are indicated below the designs in Fig. 383 to show where the cutting races occur.

After the cutting process, the twist runs out of the free ends of the weft threads which then project vertically from the foundation in the form of tufts of fibres, in the manner represented at J in Fig. 384. Each repeat of the pile weave produces one horizontal row of tufts, and in the plans A to E in Fig. 383 a complete row of tufts is formed to each ground pick.

Length of the Pile.—The length of the pile varies according to the ends per inch of the cloth and the number of ends over which the pile weft floats. An increased length of pile is obtained either by reducing the ends per inch or by increasing the number of ends over which the pile weft passes; and conversely, a decreased length results from increasing the ends per inch or from reducing the pile float. With the same number of ends per inch the designs A, B, C or D, and E in Fig. 383 give successively an increased length of pile. For example, with 72 ends per inch in the cloth the approximate lengths are respectively $\frac{1}{48}$ inch, $\frac{1}{29}$ inch, $\frac{1}{21}$ inch, and $\frac{1}{16}$ inch. The length of pile produced by the design A, with 30 ends per inch, is about the same as is produced by the plans C and D with 72 ends per inch.

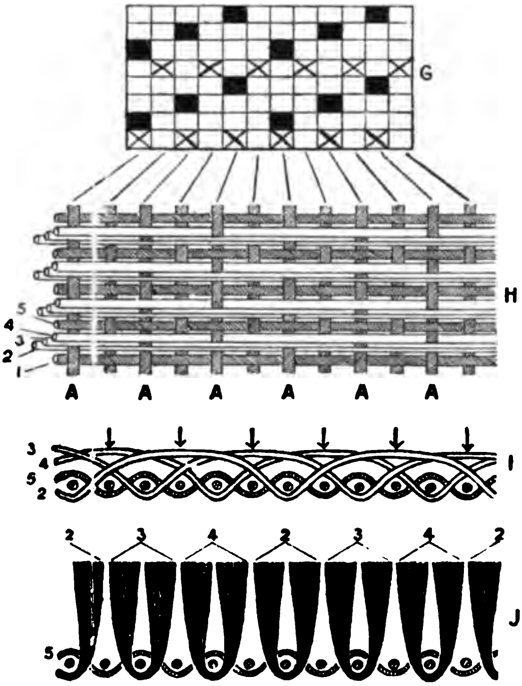


Fig. 384.

Density of the Pile.—The density of the pile varies according to the thickness of the weft, the length of the pile, and the number of tufts in a given space. An increase in the thickness of the weft tends to make the pile coarser, but other things being equal the density is increased. A long pile causes the surface of the cloth to be better covered, and thus gives a denser appearance and handle than a short pile. The greater the length of the pile is, however, the fewer are the number of tufts formed by each pile pick, and with the same number of pile picks per inch, an increase in density, due to increased length, will be counteracted by a reduction in the number of tufts. It is, therefore, customary for an increase in the length of the pile weft float to be accompanied by an increase in the number of pile picks per inch.

In each of the plans in Fig. 383, the same number of tufts per square inch will result by employing the same number of ground picks per inch. Assuming that the warp is 2/60's cotton with 72 ends per inch, and the weft is 50's cotton, 80 ground picks per inch will be suitable, which will give the following number of pile picks and total picks per inch for the designs.

Design A.—160 pile picks and 240 total picks per inch.
Design B.—240 pile picks and 320 total picks per inch.
Designs C and D.—320 pile picks and 400 total picks per inch.
Design E.—400 pile picks and 480 total picks per inch.

Comparisons of the number of tufts in different structures can be made by means of the following formula, which give the number of tufts to the square inch :—

$$\frac{\text{Ends per inch} \times \text{pile picks per inch}}{\text{Ends in repeat of pile weave}}$$

For example, with the foregoing particulars, the design B will produce—

$$\frac{72 \times 240}{6} = 2{,}880 \text{ tufts per square inch.}$$

It will be found in the same manner that the other designs with the particulars indicated will give exactly the same number of tufts to the square inch.

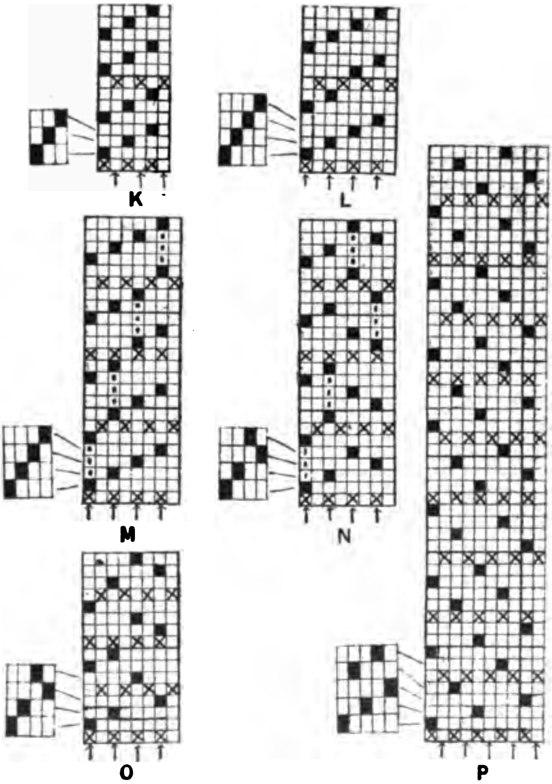


Fig. 385.

Changing the Density of the Pile.—There are different ways of changing the density of the pile, and in the same design and sett, alterations are frequently made simply by varying the number of picks per inch, or the thickness of the weft. In another method the design is changed in order to obtain a different proportion of pile to ground picks. This is illustrated in Fig. 385 where the design K has the same base weave as B in Fig. 383, but there are six pile picks, instead of three, to each ground pick. L and M are similar to C in Fig. 383 except that they have six and five pile picks respectively instead of four to each ground pick. In the same manner the designs N and O correspond with D, but have respectively five and three pile picks to each ground pick; while the design P is similar to E except that there are four instead of five pile picks to each ground pick.

The pile is most evenly distributed when, between each pair of ground picks, every binding end holds the same number of tufts, as shown at K in Fig. 385. When the modified arrangement makes it necessary for the pile weave to be extended over two or more repeats of the ground weave, a sateen base is better for the pile interlacing than a twill base. The reason for this will be understood from a comparison of the plans M and N, both of which are arranged on a 4-thread base with five pile to one ground pick. Between each pair of pile picks two tufts occur on one end in the positions where the dots connect the full squares. In the plan M on account of the pile interlacing being based on a twill weave, these positions run in twill order, which may result in a slight twilled effect appearing in the finished cloth. In N, however, the positions occur in sateen order, because a sateen pile base weave is employed, and the liability of twill lines being formed is avoided. Also, in the designs O and P, between each pair of ground picks, there is one end on which there are no tufts, and if these positions were to run in twill order there would be a similar liability of twill lines being formed in the cloth. This may be avoided by using a sateen base for the pile interlacing, as shown in the two examples.

In changing the proportion of pile picks to ground picks in a design the effect of the alteration should be considered in relation to the number of picks that it is proposed to insert under the new conditions. The alteration may be for the purpose of changing the density of the pile while retaining exactly the same total number of picks per inch as the original structure; or of changing the density while retaining a similar ground structure; or the idea may be to obtain exactly the same density as before, but with a different ground structure. The following list shows the result which will occur under the different conditions named, assuming that the weave D in Fig. 383—which has four pile picks to one ground pick—is changed to five and three pile picks respectively to each ground pick, as shown at N and O in Fig. 385. The total picks of the original

	Design.	Ratio of pile picks to ground picks.	Ground picks per inch.	Pile picks per inch.	Total picks per inch.	Tufts per square inch.	Remarks.
Original structure,	D	4 to 1	80	320	400	2,880	Original structure.
To retain same total picks as original structure,	N	5 to 1	66	334	400	3,906	Density of pile increased. Ground texture less firm.
	O	3 to 1	100	300	400	2,700	Density of pile reduced. Ground texture firmer.
To retain same density of pile as original structure,	N	5 to 1	64	320	384	2,880	Total picks reduced. Ground texture less firm.
	O	3 to 1	106	320	426	2,880	Total picks increased. Ground texture firmer.
To retain same ground texture as original structure,	N	5 to 1	80	400	480	3,600	Density of pile increased. Total picks increased.
	O	3 to 1	80	240	320	2,160	Density of pile reduced. Total picks reduced.

structure are taken as 400 per inch, giving 80 ground and 320 pile picks per inch; and the tufts per square inch are based on the cloth having 72 ends per inch.

Fastness of the Pile.—A very important feature in these fabrics is the proper securing of the pile to the foundation cloth so that there will be no liability of the tufts fraying out. In the examples given in Figs. 383, 384, and 385, the tufts are bound in by one end only at a place, and the fastness of the pile is chiefly dependant upon the pressure of the picks upon one another. It is therefore necessary, particularly in the longer piles, for a very large number of picks to be inserted in order to keep the pile firm. If it is desired to introduce fewer picks per inch, or to make a very long pile, the necessary firmness can be secured by interweaving the pile picks more frequently, making what is termed a "fast" or "lashed" pile. The examples Q, R, and S, given in Fig. 386, respectively show how the plans C, D, and E in Fig. 383 may be made firmer. The section, shown at T, illustrates how the tufts, formed by the picks five and six of the design S, are bound in. By comparing the designs given in Figs. 383 and 386 it will be seen that with the same number of ends per inch Q and R will each produce the same length of pile as B, and S, as C or D. The firmer interweaving renders it more difficult to insert a large amount of weft, and it is generally recognized that in a fast pile the richness of the cloth will suffer, but there is the advantage that the greater firmness gives the cloth better wearing qualities.

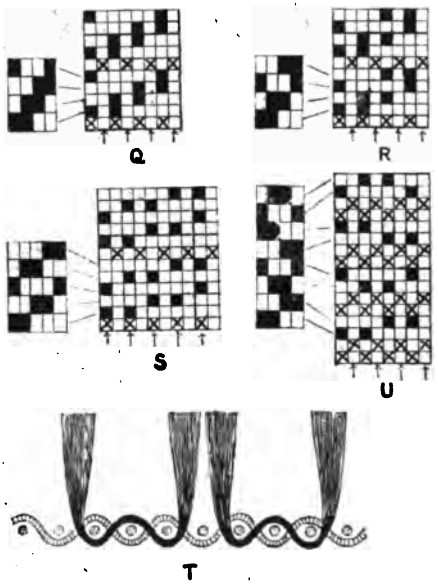


Fig. 386.

A plan for a very thin pile structure is given at U in Fig. 386, in which the arrangement is two plain ground picks to two "fast" pile picks. The idea in this case is for the pile to be developed—say in black weft—upon a coloured foundation of a tartan character, which will show through the thin pile covering. The presence of the pile tends to make the foundation colours appear deeper and richer.

Twill-back Velveteens.—Examples of velveteens with a twill foundation are given in Fig. 387, A, B, and C having a 1-and-2 twill or "Genoa" back, while the ground weave of D and E is 2-and-2 twill. A twill foundation weave is looser than a plain, and, therefore, not only permits, but, in order to maintain the same firmness of pile, requires a large number of ground picks to be inserted. Hence, with the same ratio of pile to ground picks, more pile picks can be put in and a denser pile formed. Also, a cloth with a twill ground is softer and more flexible than a similar cloth with plain ground; the latter ground, when very heavily wefted, tending to make the cloth handle somewhat hard and stiff.

In A, B, and C in Fig. 387. the pile weave is based on 1-and-2 twill which, as before, is marked on alternate ends; the pile picks are arranged in the proportion respectively of two, three, and four to each ground pick. The 1-and-2 twill foundation weave of these designs is invariably made with the weft float on the under side of the cloth. This provides a better surface than a warp twill back for binding in the pile picks and covering them on the underside. Also, the 2-and-1 weft surface is suitable for the application of a raised or flannelette finish to the back if such is required.

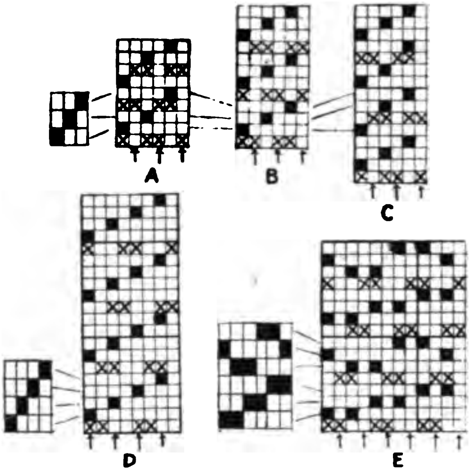


Fig. 387.

It may be noted that A in Fig. 387 is the standard design for the moleskin class of fabric, which is usually made in coarse cotton yarns. This is not a pile fabric, as the floating picks are not cut but remain in the condition they are after weaving. The cloth is very strong and leathery, and is eminently suitable for workmen's clothing which is subjected to very hard wear.

A 2-and-2 twill foundation weave enables a very large number of ground picks to be readily inserted, and is therefore used for the heaviest and densest velveteens. In the design D, Fig. 387, the pile weave is based upon 1-and-3 twill, and there are four pile picks to each ground pick, while in E, a six-thread sateen pile base weave is employed with the pile made fast, and there are three pile picks to each ground pick.

Designs which Simplify the Cutting Operation.—The designs given in Fig. 388 illustrate a method of arranging the pile interlacing that is sometimes employed with the object of reducing the time occupied in the pile cutting. In F, G, and H, the pile base weaves are indicated only on every third end, therefore, only one-third as many longitudinal traverses of the cutting knife are required, as there are ends in the width of the cloth to be cut over. Compared with the examples in which the binding of the pile picks occurs on alternate ends, the number of cutting races is reduced by one-third. The distribution of the pile, however, is not so perfect, and the surface of the cloth has a coarser appearance. I in Fig. 388 shows a fast pile effect in which the pile interlacing is based on a 1-and-2 twill weave doubled; and as indicated by the arrows below the design, the cutting races occur only on every fourth end.

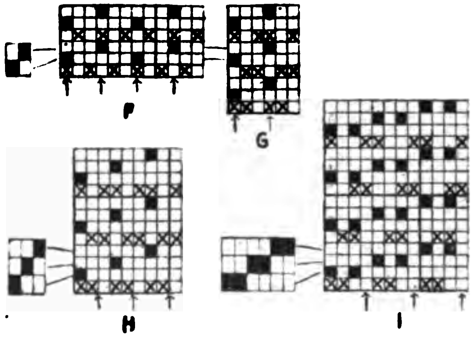


Fig. 388.

CORDED VELVETEENS

In these structures the pile picks are bound in, at intervals, in a straight line. The cutting knife is run right up the centre of the space between the pile binding points, with the result that the tufts of fibres project from the foundation in the form of cords or ribs running lengthwise of the fabric. An illustration of a cloth is given in Fig. 389, which shows in the upper and lower portions respectively, the appearance of a corduroy before and after the operation of cutting.

The finer classes of cords, such as are used for children's clothing and dress fabrics, are largely made in fine yarns with a plain back. The corduroys, used for men's clothing, are made stronger and heavier, and a twill foundation weave is mostly employed. In the heavier cloths thicker weft is used, and consequently fewer pile picks to each ground pick are necessary, usually not more than two being employed.

In the simplest cord designs, the pile picks are bound in in plain order on two consecutive ends. J, K, L, and M in Fig. 390 are examples with a plain back which, in the same sett, yield successively an increased width of cord. Thus, with 72 ends per inch in the finished cloth the number of cords per inch will be J-12, K-9, L-7, and M-6. Designs may be constructed to produce other widths of cords simply by varying the space between the binding ends.

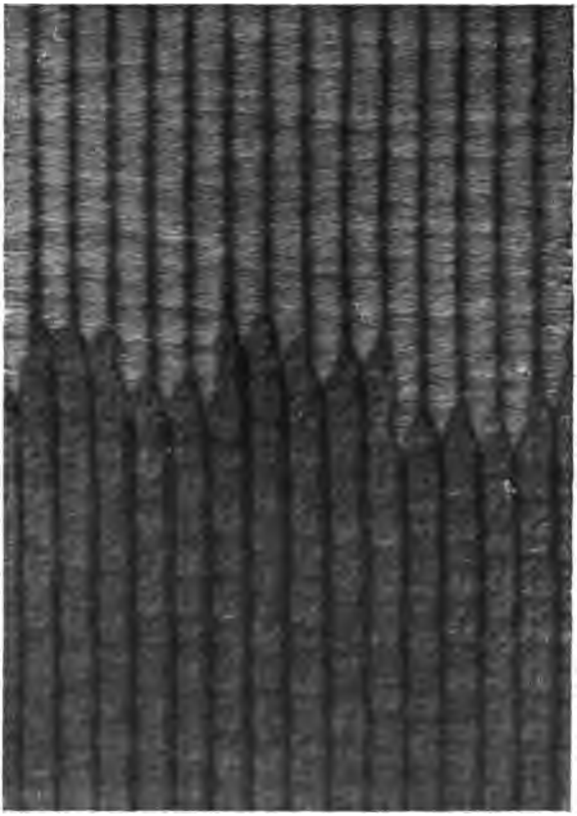


Fig. 389.

The plain binding weave of the pile picks may be reversed in alternate cords, as shown at J, in which case the design extends over the width of two cords, and each pile pick forms alternately a long and a short float. On the other hand, the pile binding may be the same in each cord, as shown at K, and in this case all the pile floats are equal. The result is practically the same whichever method of binding is adopted, because the floats are cut as nearly as possible in the middle of the space between the pile binding points; consequently, in either case, one side of each tuft is longer than the other side. The difference in the lengths causes the ribs to have a rounded formation, as the long side of the tufts forms the centre, and the short side the outer parts of the cords. This is illustrated by the drawing given at N in Fig. 390, which shows on the left how the picks of the plan K interlace, while on the right the appearance of the cord, after the cutting, is represented. The arrows indicate the position of the cutting races. Similar effects are produced by the designs L and M, but here there are three and four pile picks respectively to each ground pick.

Examples of cords with a 1-and-2 twill back are given at O and P in Fig. 390, and with a 2-and-2 twill back at Q, R, and S. These are arranged two pile picks to each ground pick, and in producing very heavy structures they are woven with comparatively few ends per inch, the number varying from about 28 to 36.

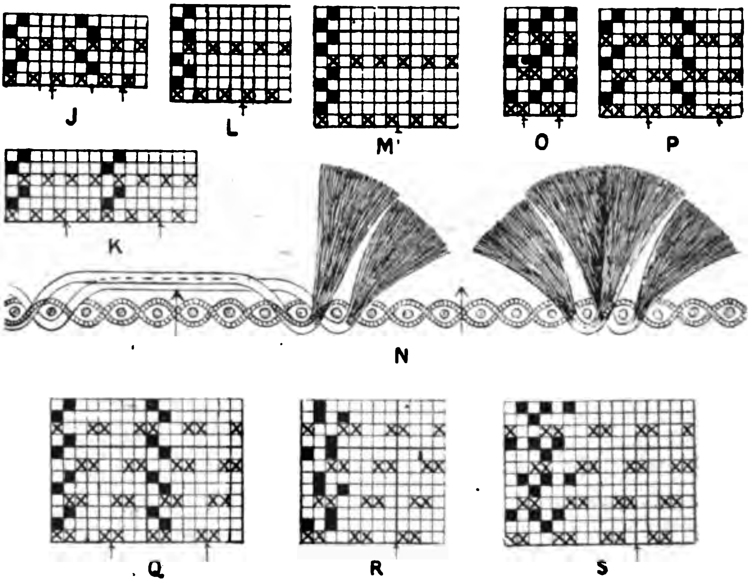


Fig. 390.

The cords, produced by the design O in Fig. 390, are only three ends wide, and both sides of the tufts are of equal length ; therefore, the ribs are not rounded, and a poor and bare structure results. P is similar to J except for the difference in the ground weave, the pile floats being of different sizes, and the complete design extending over the width of two cords. Q is similarly arranged, but in R and S (which are used for specially heavy and wide cords), alternate pile picks are interwoven more frequently with the object of producing greater variety in the length of the tufts, and so cause the rounded formation of the ribs to be more pronounced.

Corded Velveteen Cutting.—The cutting of cord designs, by hand, is much more readily accomplished than in the case of plain velveteens, as only one traverse of the knife is required for each cord. In the lower classes of cords the cutting operation is now largely facilitated by the aid of machinery, of which there are two chief types. In one method, which is the simpler, the two ends of a piece are sewn together and the cloth is passed rapidly under tension through a machine during which a cord is cut the full length except for a few inches at either end. The knife is similar to the kind used in hand cutting, and at each complete passage of the cloth the machine is stopped while the guide is inserted in the next cord. The cloth makes as many passages through the machine as there are cords to be cut.

In the second type of machine all the cords are cut at the same time by means of circular knives, one to each cord, placed upon a revolving shaft. Each knife rotates within a slot formed in a guide, the pointed end of which is inserted under the pile floats in the centre of a cord. By means of tension rollers the cloth is drawn forward horizontally towards the knives, but at about the point of contact with the latter, it is taken downward over the edge of a transverse bar. The floating pile picks are brought by the guides into the path of the revolving knives and are cut, while the cloth passes downward and is either wound on a beam or is plaited down.

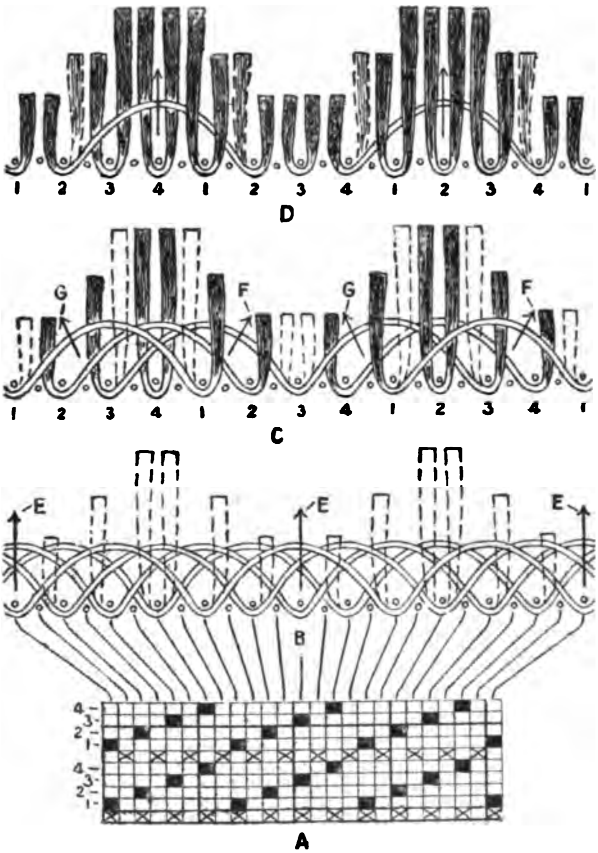


Fig. 391.

Corded Velveteens from Plain Velveteen Weaves.—In addition to the corded velveteens in which the rib formation is due to the pile picks being bound in in a straight line, as shown in Fig. 390, cord effects are now largely made by hand-cutting from plain velveteen weaves. In the latter system tufts are produced of different lengths, so as to form rounded cords, simply by the way in which the pile is cut. The width of the cords is not determined by the repeat of the pile weave, and in the same weave different widths of cords may be formed. It is customary, in this system, for the cutting to be performed at two operations: first on a short frame, and then on a long frame. Different forms of knives are used, the blade being supported vertically in cutting certain races, and at an angle in cutting other races. A simple example, to illustrate the principle, is given in Fig. 391, in which A shows an ordinary plain-back velveteen weave repeating on eight ends. Corresponding sections through the warp are given at B, C, and D, which represent in stages how the pile picks are cut. The interlacing of the four picks that constitute a repeat of the pile weave, is indicated at B, the warp threads in which are shown connected by lines with the corresponding vertical spaces of the plan A. The arrows lettered E indicate the position of the first series of cuts which, in the example, occur at intervals of twelve ends. These cuts are made on the short frame system throughout the length of the piece, with the blade supported vertically, and care is taken in starting that the races are the proper distance apart to give the required width of cord. All the floating pile picks, which are in line with the stroke of the knife (three out of every four), are severed, and the free ends then assume the position represented by the dotted lines in B, three different lengths of pile being formed.

After this portion of the cutting has been effected, the cloth is taken to a long frame, and a second series of cuts is made with the blades supported at an angle, as indicated by the arrows F in the drawing C. Then a third series of cuts is made with the blade inclined in the opposite direction, as shown by the arrows G. In each race one pick in every repeat of the pile weave is severed, and the free ends assume the positions shown by the dotted lines in C. The final series of cuts is made in the positions shown by the arrows in the drawing D, and the blade in this case is held vertically.

The numbers below C and D indicate the order in which the pile picks are inserted, and by comparing the drawings, noting the order in which the cuts are made, the gradual evolution of a corded pile effect from a plain velveteen weave will be understood. This system of cutting is more costly than the cutting of proper corduroy, but for ladies' and children's wear it has the advantage that the cloth is softer and more flexible. The two types of cord may be readily distinguished by the feel of the cloth.

Particulars of Weft Pile Fabrics.—The weaving particulars, of a number of the foregoing examples, are given in the accompanying table, and in order that comparisons may be made the width in the reed for 24 inches grey, the calculated grey weight of 100 yards of cloth, 24 inches wide, and the approximate number of tufts to the square inch in the finished cloth are stated. The particulars of A, Fig. 387, are suitable for a moleskin fabric.

A feature to be noted is the great shrinkage in width from the reed to the cloth, which varies from about 12½ per cent. in the lighter velveteens to 20 per cent. in the heavy cords. There is very great tension put on the warp (a positive shedding motion is mostly used), and the shrinkage in length is very slight. For this reason all the warp is usually brought from one warp beam, although some of the ends are much more frequently intersected with the weft than others.

In any design the weight of the cloth can be varied extremely by varying the ends per inch and the thickness of the weft. Reducing the sett of the warp enables more weft to be put in, and the excessive weight of the heavy cords is obtained by employing a loose foundation weave with few ends per inch. A very good quality of cotton is required for the warp, because of the great strain put upon it, and in the best cloths the finest fibred cottons are used for the weft. The finer the fibres are, the more are required in forming a given size of thread, and the more are contained in each pile tuft.

Design.	Counts of cotton warp.	Counts of cotton weft.	Ends per inch in reed.	Ends per inch in cloth.	Ground picks per inch.	Pile picks per inch.	Total picks per inch.	Length of warp 100 yards cloth.	Width in reed for 24 in. grey.	Calculation weight of 100 yds. 24 in. wide.	Tufts per square inch.
B, Fig. 383,.	2/60s	40s	72	81	75	225	300	104	27"	32 lbs.	3,200
C and D, Fig. 383,	2/70s	60s	72	83	88	352	440	103	27⅔	31 lbs.	3,700
E, Fig. 383,	2/80s	70s	76	88	90	450	540	103	28	32 lbs.	4,800
A, Fig. 387,	2/20s	16s	38	44	80	160	240	102½	28	63 lbs.	4,500
B, Fig. 387,	2/80s	70s	72	84	108	324	432	102½	28	26·7 lbs.	4,600
C, Fig. 387,	2/70s	60s	72	84	104	416	520	102½	28	35·8 lbs.	5,900
L, Fig. 390,	2/60s	50s	72	87	92	276	368	104	29	34 lbs.	2,350
O, Fig. 390,	2/16s	22s	28	34	90	180	270	102½	29	54·7 lbs.	1,040
P, Fig. 390,	2/20s	18s	30	37	140	280	420	102½	29½	82·7 lbs.	1,760
Q, Fig. 390,	2/18s	18s	32	39	170	340	510	102½	29½	112 lbs.	1,680
R, Fig. 390,	2/16s	18s	32	40	144	288	432	102½	30	100 lbs.	980

WEFT PLUSHES

The designs for these fabrics are constructed on exactly the same principle as plain velveteens, but the pile floats are longer and more firmly bound in, while the cloths are frequently very heavy. In the plan A in Fig. 392, the pile interlacing is based on a 4-sateen weave, and there are four pile picks to each ground pick. With the following particulars a long pile is produced which is developed in mohair worsted weft :—Warp, 2/30's cotton, 44 ends per inch ; weft, 1 pick 20 skeins woollen, 2 picks 8's mohair, 144 picks per inch. This design is used for weft pile Astrakhan structures, the mohair weft, previous to weaving, being boiled while wound round a spindle or twisted tightly in the hank. This treatment causes the mohair when slack to curl up, hence after the pile-cutting operation, the free ends of the tufts form curls on the surface, and give the cloth the characteristic Astrakhan appearance.

In the plain-back velveteen structures previously given, all the pile picks go into the same shed as one ground pick, and in the opposite shed to the other ground pick. This causes a slight irregularity in the lower picked cloths, which, however, is quite imperceptible in the finer fabrics when finished. In some of the long and coarse weft pile structures, the irregularity is got over in the manner illustrated by the design B in Fig. 392, in which the plain ground texture is modified, so that each group of two pile picks is in the same shed as the preceding ground pick, and in the opposite shed to the ground pick that follows. Suitable weaving particulars for the design are :—Warp, 2/32's cotton, 50 ends per inch ; weft, 1 pick 26 skeins woollen, 2 picks 16's mohair, 150 picks per inch.

The design C in Fig. 392 is arranged two ground to one pile pick, and the pile interlacing is based on an irregular 8-sateen weave. This design is used for a heavy type of weft plush termed "dogskin," in which a long mohair pile is developed with the following weaving particulars :—Warp, 2/24's cotton, 40 ends per inch : weft, 2 picks, 2/20's cotton, 1 pick, 3's mohair, 60 picks per inch.

In the design D in Fig. 392 the pile interlacing is based on a 5-sateen weave, and to each ground pick there are two pile picks. One pile pick, however, has a longer float than the other, so that two different lengths of pile are formed in the cloth. Variety of effect can also be obtained by having the pile picks alternately in different colours or different materials. The following are suitable weaving particulars :—Warp, 2/40's cotton, 48 ends per inch ; weft, 1 pick 24's cotton, 1 pick 28's mohair (shade 1), 1 pick 28's mohair (shade 2), 216 picks per inch.

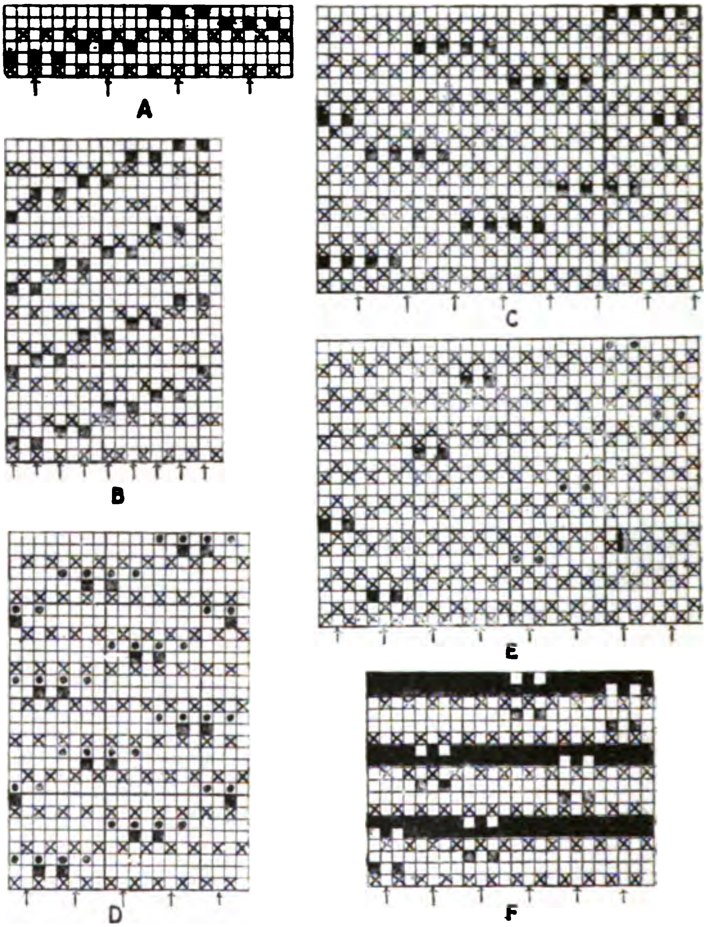


Fig. 392.

The design E in Fig. 392 illustrates an effective method of developing the pile in different materials or colours. The pile interlacing is based on an irregular 8-sateen weave, but the binding of the odd pile picks, shown by the full squares, occurs on one-half of the plan, while that of the even pile picks, represented by the dots, occurs on the other half. By arranging the pile picks alternately in different colours or materials, stripes of pile are formed on the surface.

The design F in Fig. 392 shows the arrangement of a reversible weft plush, a structure that is sometimes used for carriage rugs. The cloth has a plain centre, and the pile binding places are arranged in 6-sateen order on both sides. The following weaving particulars are suitable:—Warp, 2/30's cotton, 48 ends per inch; weft, 1 pick 30 skeins woollen, 2 picks 12's mohair (face), 1 pick 30 skeins woollen, 2 picks 12's mohair (back), 144 picks per inch. The pile on the back may be developed in a different colour from that on the face.

FIGURED WEFT PILE FABRICS

Plain woven velveteen cloths are sometimes figured by printing or embossing in the manner described in reference to warp pile textures (p. 405). In true weft pile figuring the ground of the design is produced by throwing the pile picks to the back of the cloth, so that the foundation shows on the surface and forms a background to the figure. The ground is bare and dull in appearance compared with the pile surface, and for this reason, and in order to make the best use of the large quantity of weft that is put into the cloth, the most suitable designs are those in which the pile figure is massive, and covers nearly the whole of the face of the fabric.

Figured Velveteens.—Fig. 393 represents a figured velveteen fabric in which the design is typical of the kind that is mostly employed; it will be seen that the ground is shown chiefly in order to separate the parts of the ornament. Practically any velveteen weave can be used for the figure, but in the ground the structure is varied according to the method in which the pile weft is prevented from showing on the surface. There are two chief methods of disposing of the surplus weft in the ground:—(1) It is bound in on the underside in the same manner as on the face. (2) It is floated loosely on the back of the foundation texture, and after the cutting operation is brushed away as waste. In the latter method, if

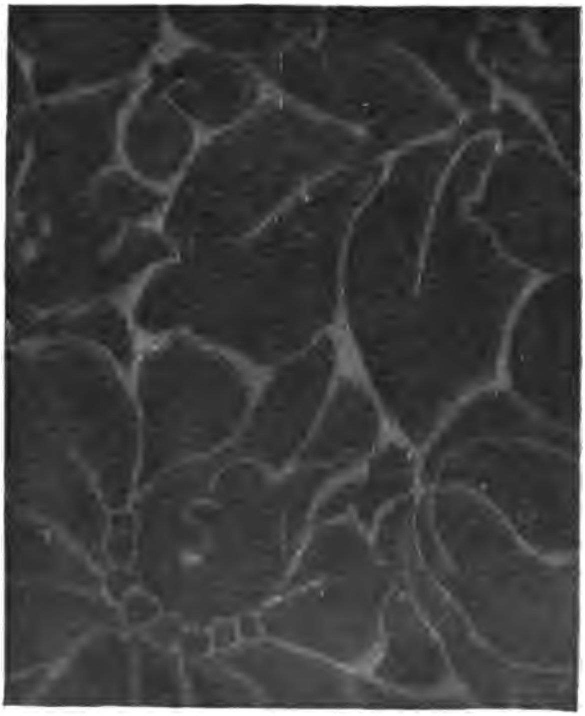


Fig. 393.

very long floats are formed on the underside, sometimes a series of extra ends is introduced which interweave only with the pile picks on the back. A coarse cloth is thus formed on the underside, which, after the cutting operation, is pulled away leaving the ground clear of the pile weft.

The velveteen weaves that are chiefly used for the pile figure are given at A and C in Fig. 394. If the pile picks are bound in on the back, corresponding methods of interlacing, as shown at B and D respectively, are employed in the ground, but the pile binding points are placed in different relative positions to the face binding points.

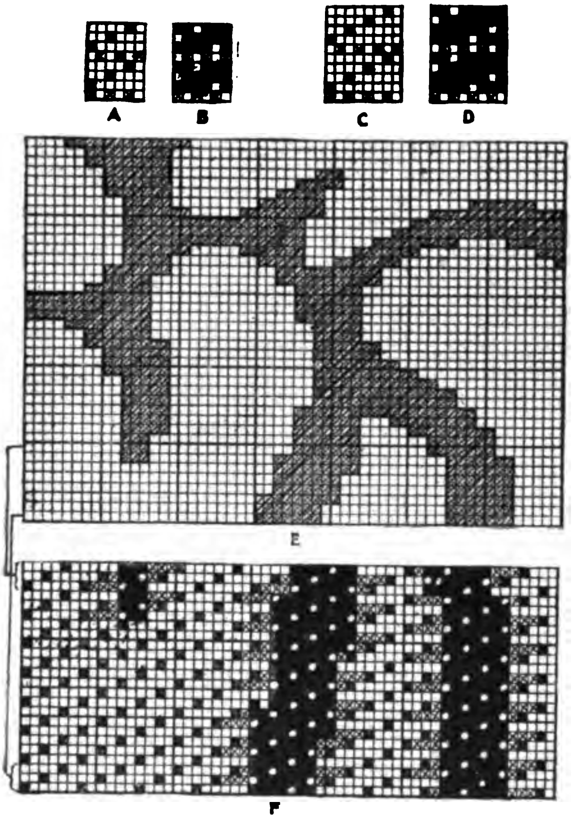


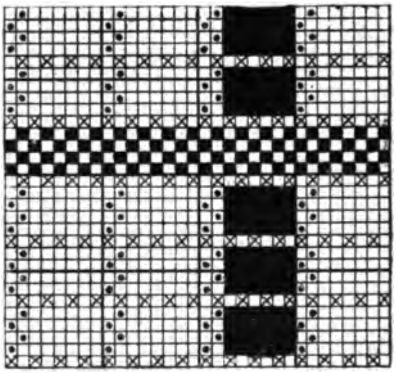
Fig. 394.

In drafting a design upon point-paper, the pattern may be drawn and painted out in full from the original motive; but on account of the great preponderance in number of the picks over the ends it is advisable to adopt a method which will simplify the work. In one method the design is first drafted to a reduced scale, as shown at E in Fig. 394, in which each vertical space represents an end, and each horizontal space a ground pick and as many pile picks as are inserted to each ground pick. This proportion is convenient for the subsequent process of drafting, and it enables suitable design paper for the reduced plan to be readily selected, as the counts of the paper is in the same ratio as the ends are to the ground picks per unit space. Thus, assuming that the pile weave given at A is employed, and the cloth in the finished state contains 80 ends and 320 picks per inch, the counts of the design paper is in the proportion of 80 to (320 ÷ 4) = 8 × 8. As the figure nearly covers the surface of the cloth it is convenient to paint the ground of the design, as shown at E in Fig. 394.

The complete card-cutting plan is constructed from the reduced design in the method illustrated at F in Fig. 394, in which the figure is formed in the weave given at A, and the ground in that shown at B. Each horizontal space of E corresponds to three spaces of F, the ground picks not being included in F, because they are all plain, and can be cut independently of the design.

Figured velveteens are more difficult to cut than plain velveteens on account of the liability of the knife guide leaving the races between the separate parts of the figure. It has been found by experiment that the best results, as regards the pile cutting, are secured, first, by painting the outer edges of the ground portions on the bound ends; and, second, by making each pile weft float pass over at least five ends at the edges of the figure. It will be seen in E, Fig. 394, that the edges of the ground effect are indicated on the odd ends which are shown bound in the plan F, while the outline steps in pairs of ends. The crosses in F illustrate the method of taking out all pile floats of less than five at the edges of the figure. The marks in the plan F are cut.

The method of indicating a design, shown at F, may be employed when the pile weft is not bound in in the ground, except that no binding marks are indicated in the ground portion of the design. It has to be taken into account, however, that the removal of the surplus weft from the underside causes a half tuft formed by each pile pick to be drawn away on both sides of every portion of figure. The latter method, as compared with the former, therefore increases the ground space, and if care is not taken in indicating the cutting marks of a design, a narrow portion of figure may be eliminated. In order to preserve the full mass of the figure, instead of throwing all the small floats to the back, as shown by the crosses in F, the three floats may be extended to floats of five on the surface by taking out marks in the ground.


G

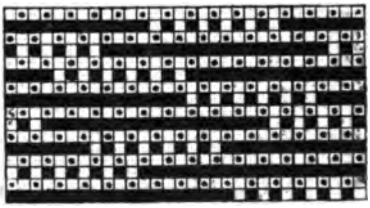

H

Fig. 395.

Figured Cords. — Any standard cord weave may be employed as the basis of the structure in producing a figured velveteen cord, but as it is necessary for the outline of the figure to fit with the vertical cord lines, more elaborate ornamentation can be produced in narrow than in broad cord effects. In any case the steppy character of the lines makes it necessary for the designs to be simple and massive, and, as a general rule, the styles are limited to simple geometrical figures. The ground effect is produced by floating the pile weft on the back between the binding ends, but there is the exception that in check patterns the horizontal lines can be formed simply by discontinuing the pile weave and inserting the required number of ground picks consecutively.

In the plan shown in Fig. 395 the solid marks illustrate the formation of ground lines in a corded velveteen structure, the vertical series of marks indicating the usual way in which the pile picks are thrown to the back in forming the ground of an effect, and the horizontal series, the method of producing a horizontal line of ground in a corded check.

IMITATION OF WEFT PILE FABRICS

A form of weft curl pile is produced by combining a shrinking with a non-shrinking weft, and submitting the cloth to very great contraction in the finishing processes. Woollen and mohair wefts may be used, inserted one or two picks of each alternately, and a cotton warp. The woollen weft is interwoven in perfectly plain order with the warp, while the mohair weft is interwoven in plain order for a number of threads, and is then floated loosely on the surface. The method is illustrated by the plan given at H in Fig. 395, in which the dots represent the woollen picks, and the solid marks the mohair picks. The cloth is heavily milled, and shrinks excessively in width, but the mohair floats do not contract, and are, therefore, caused to form loops or curls on the surface.

In another form of imitation weft pile a fabric is produced with a fibrous surface which, to some extent, resembles various skin and plush textures. The cloth is woven with cotton warp, and a weft that consists of a mixture of cow's or calf's hair and a low quality of wool. The weave is usually an ordinary four- or five-thread weft-sateen, but sometimes a reversible weft-face weave (as shown in Fig. 7, p. 8) is used in order that the cloth will be the same on both sides. The pile effect is produced in the finishing operation by submitting the cloth to very severe processes of milling and raising. In the dyed or printed condition the fabrics are used for such purposes as curtains, upholsteries, and carriage rugs.

CHAPTER XVII

TURKISH TOWELLING FABRICS

Formation of the Pile—Turkish Towelling Weaves—Methods of Drafting and Denting—Terry Motions. *Terry Ornamentation*—Stripe and Check Dobby Patterns—Figured Terry Pile Fabrics—Mixed Colour Effects.

The Turkish towelling structure forms a class of warp pile—termed "terry" pile—in which certain warp threads form loops or curls on the face of the cloth. Only one kind of weft may be used, but two series of warp threads, placed on separate beams, are necessary for the production of the cloths—viz., ground threads and pile threads. The former produce with the weft a foundation texture from which the loops, formed by the pile threads, project.

The distinguishing feature of this class of pile, as compared with true warp pile, is that the looped structure is produced, not by the aid of wires, but by employing a special reed motion and warp easing arrangement which enable the loops to be formed on the upper or lower, or both upper and lower, surface of the cloth. Turkish towels may be made in either linen or cotton yarns, and in cotton yarns the structure is applied, in addition to towels, to such fabrics as counterpanes, mats, dressing gowns, and toiletings. The principle has also been employed in the manufacture of cheap mantle cloths in which the pile is developed in yarns made from wool.

Formation of the Pile.—In forming the looped pile without the aid of wires, many different kinds of terry motions are used, but in every case the object is to cause two succeeding picks of weft to be left a short distance from the fell of the cloth, and then to beat up these two picks along with the following pick.

In Fig. 396 a longitudinal cross-section of a double-face plain pile fabric is given, which shows the weft threads in relation to the ground and pile warp threads. The dotted vertical lines R R, S S, and T T divide the picks 1, 2, and 3 into repeating groups of three, line T T indicating the position of the fell of the cloth. On the right of the diagram, a group of three picks, which compose a repeat, is represented previous to being beaten up to the fell of the cloth. The ground threads G, G^1, and the face and back pile threads F and B are shown connected by lines with the respective spaces in the corresponding weave design given at P. In weaving the cloth the ground warp beam, carrying the threads G and G^1, is heavily tensioned, so that these threads are held tight all the time. The picks 1 and 2 are first woven into the proper sheds, but are not beaten fully up to the fell of the cloth by the slay at the time of insertion in their sheds; but when the pick No. 3 is inserted the parts are so operated that the three picks are driven together into the cloth at the fell T T. During the beating up of the third pick the pile warp threads F and B are either given in slack, or are placed under very slight tension.

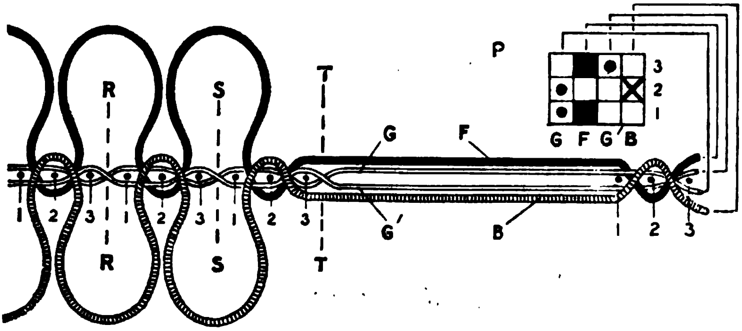


Fig. 396.

The picks 1 and 2 are in the same shed made by the tight ground threads G and G^1, which, therefore, offer no obstruction to the two picks being driven forward at the same time with the third pick. The pile threads F and B, on the other hand, change from one side of the cloth to the other between the picks 1 and 2, and they are, therefore, gripped at the point of contact with the two picks. As the three picks are beaten up this point of contact is moved forward to the fell of the cloth, with the result that the slack pile warp threads are drawn forward, thus forming two horizontal rows of loops, one projecting from the upper and the other from the lower surface of the cloth in the manner represented in Fig. 396.

In order to produce the loops on the three picks during the insertion of which the terry motion is in operation, the pile and ground threads must be interwoven with the weft in the exact order represented in Fig. 396. The three-pick terry structure is employed most extensively, but sometimes four, five, and even six picks are inserted in making each horizontal row of loops. The interweaving of the threads, on the subsequent picks, is, however, of little consequence so long as the cloth has the necessary firmness, and a natural connection is made with the weave of the three picks particularly referred to.

Turkish Towelling Weaves.—A number of standard designs for producing the fabrics are given in Fig. 397. These designs have been grouped so that comparisons can be readily made. The dots in the designs represent the interlacings of the ground warp threads; the full squares show the interweaving of the face pile threads, and the crosses of the back pile threads. Designs A, B, C, D, and E form the loops uniformly on the face side of the cloth only, whereas the remaining designs are for producing a pile surface on both sides of the cloth. In the designs A, B, C, D, and E, the warp threads are arranged 1 ground, 1 face pile, and in F, G, H, I, J, and K, 1 ground, 1 face pile, 1 ground, 1 back pile. The designs L, M, N, O, P, and Q produce corresponding effects to the designs F to K respectively, but they are arranged 1 ground, 1 face pile, 1 back pile, 1 ground.

In each design A to E in Fig. 397, there is a pile thread on the surface to each ground thread, but in the remaining designs F to Q, the proportion is one pile thread on each side of the cloth to two ground threads. The single-face pile cloths can, however, be made with one pile to two ground by leaving out the last thread in each of the designs A to E. The plans A, F, and L are for producing the pile effect on three picks; B, G, and M on four picks; C, H, N, D, I, O, J, and P on five picks; and E, K, and Q on six picks.

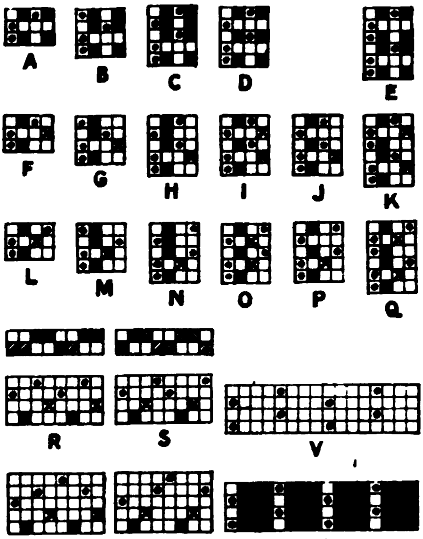


Fig. 397.

The five-pick effects, C, H, and N, are respectively similar to D, I, and O, except that the pile threads interweave more frequently in the latter three, while J and P show a further modification in which the face pile threads interweave more frequently than those which form the back pile. Less weft yarn can be introduced into the cloth with the more firmly interwoven designs, and at the same time the resulting structure is stronger and more durable.

In the six-pick effects E, K, and Q, the ends interlace with the picks in exactly the same manner as in A, F, and L respectively, but in producing the loops at every six picks, the weft is beaten up to the fell of the cloth on four picks in succession. This structure, which is known as the "Osman," is much firmer than the three-pick terry, on account of the greater number of intersections that are made for each horizontal row of loops; and with finer yarns and more picks per inch, the cloth is made very strong and durable.

Every plan in Fig. 397 is constructed for the first and second picks to remain back from the edge of the cloth when they are first inserted, and for the reed to beat up firmly on the third and subsequent picks in the repeat. A comparison of the designs will show that in each case the interweaving of the respective threads is exactly the same on the picks 1, 2, and 3, and corresponds with the order of interlacing illustrated in Fig. 396. Thus, on the picks 1 and 2, the odd ground threads are raised and the even ground threads depressed, while on the third pick they are in the reverse positions. The face pile threads are raised on the picks 1 and 3, and depressed on the second pick; the back pile threads being operated in the reverse order.

Methods of Drafting and Denting.—In drawing in the two warps for weaving, the pile threads are drawn on two healds at the front, and the ground threads (if the looped formation is to be continuous) on two healds at the back, as shown at R in Fig. 397 for the 1 ground, 1 pile order of arrangement, and as indicated at S for the 2-and-2 order. When, however, the cloths are made in short lengths with a cross-border at each end, the drafts given at T and U are frequently employed. This arrangement enables a weave with a weft float over seven warp threads to be obtained by the alternate lifting of the third and fifth heald, the remaining healds being left down in forming the float on the face, and lifted in forming the float on the reverse side, as shown respectively at V and W. In dobby shedding specially crammed and coloured cross-over effects (headings) can be readily formed in the borders in this manner.

Usually two threads are placed in each split of the reed, and in the 1 ground, 1 pile order, one of each series is placed in the same split, as shown above R in Fig. 397. In the 2 ground, 2 pile order, however, two ends of the same series are placed together, as shown above S. The two arrangements produce practically identical results, but the 2-and-2 structure has the advantage that by reeding as described, the threads in each split work opposite to each other, and at the same time the pile and ground threads, which on some picks work alike, are separated by the wires of the reed, so that a clear shed is more readily obtained.

The loom particulars of a good quality of cotton terry cloth are as follows :—

Pile warp, two ply 2/20's ; ground warp, 2/18's ; weft, 16's ; ends per inch, 50 ; picks per inch, 58. 500 yards of pile warp and 102 yards of ground warp are required for producing 100 yards of terry. The shrinkage in width is about 12 per cent. In cheaper cloths the weft may be 20's, and the picks 36 per inch and upwards ; the pile warp 16's and the ground warp 14's ; 300 yards and upwards of pile warp for 100 yards of cloth. The ground ends are usually rather thicker than the pile ends. For a soft cloth the pile yarns should be soft spun, and for a crisp handle, moderately hard spun ; but the feel of the texture varies according to the depth of the pile loops, a deep pile handling softer than a short pile. The depth of the pile is determined by the distance that the two picks are left away from the fell of the cloth, which is usually about ½ inch.

Terry Motions.—Different systems have been devised to enable two successive picks of weft to be left back from the edge of the cloth at will. In one method, in which a fast reed is employed, the going part is moved forward for a shorter distance on the two "loose" picks ; while in another fast reed type, movable front and back rails are provided, which enable the edge of the cloth to be traversed, when required, in advance of the stroke of the reed for the necessary distance. In the system which meets with the greatest favour, however, a loose reed is used which is caused to move backwardly at the bottom, the upper edge of the reed acting as the fulcrum.

An end view in partial cross-section of this type of terry motion (as made by Messrs. Butterworth & Dickinson, Ltd., Burnley) is given in Fig. 398, in which the mechanism is under the control of a dobby or jacquard. However, in weaving cloths in which the looped formation is continuous, the principle may also be adapted to cam shedding. The parts of the reed motion are indicated in solid lines and the framework of the loom in dotted lines. A front view of the upper part of the mechanism is shown in Fig. 398, A.

The position of the reed S, during the beating up, is governed by the shedding mechanism through a cord A, which is attached to a lever B fulcrumed on a bracket

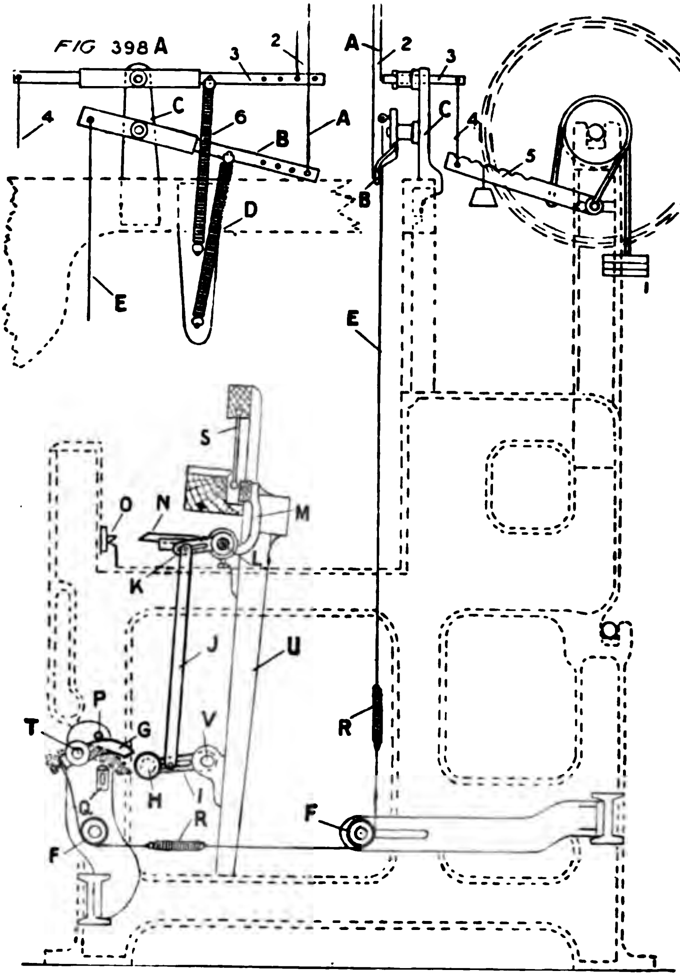


FIG 398 A

Fig. 398.

C. If the reed is required to be held firmly, the cord A is not lifted, and then the action of the spring D causes the rear end of the lever B to be raised. The cord E, which is connected to this end of the lever B and which passes around two guide pulleys F, draws upon the rear extremity of a cam G centred at T, and raises the curved portion of the cam to the position shown in solid lines. Then, as the going part moves forward, an anti-friction bowl H (carried at the end of a lever I which is fulcrumed at V on a bracket attached to a sword U) passes below without touching the cam G, and the lever K, to which the link J is connected, occupies its normal position. The lever K is fixed to the stop-rod L, as are also the lever M (which presses against the lower edge of the reed) and the duck-bill N. In beating up the weft this duck-bill engages the underside of the heater O, and the reed is held firmly in the usual manner.

When the reed is required to fall back on the first two picks, the cord A is raised which lowers the rear end of the lever B.. This action releases a sufficient length of the cord E to allow the curved portion of the cam G to fall by its own weight to the position indicated by the dotted and shaded lines. Then, as the sword U moves forward, the bowl H comes in contact with and rises on the face of the cam G. By means of the link J, this upward motion is transmitted to the lever K, which partially rotates the stop-rod L. The forward end of the duck-bill N, therefore, rises above the heater O, while the upper end of the lever M falls back, with the result that the lower edge of the reed moves backwardly, and the pick of weft is left a short distance from the fell of the cloth.

The extent of the backward movement of the reed may be regulated by moving the ends of the link J nearer to or further from the extremities of the levers I and K. Projections P and Q are used for the purpose of limiting the movement of the cam G. One or more springs R may be inserted in the length of the cord E in order to take up any excess movement of the shedding mechanism.

It is usually convenient to place a large quantity of yarn on the pile warp beam in order to compensate for its rapid delivery. This beam is supported by brackets at a considerable height above the line of the shed. During the production of the terry effect the pile warp is lightly tensioned, as shown in Fig. 398, by means of adjustable weight 1, but provision is made for increasing the tension whenever the looped formation is required to be discontinued. Thus, when the cord 2 is raised by the shedding mechanism the other extremity of the lever 3, to which the cord 4 is attached, is depressed; therefore, the beam-lever 5, to which the opposite end of the cord 4 is connected, is lowered, and additional weight is put on the pile warp beam. In the case of a towel with a border at each end, the cord 2 is left down while the terry centre is being woven, and the action of the spring 6 causes the beam-lever 5 to be raised, the additional weight thus being taken off. During the formation of the borders, however, in which the pile warp requires to be practically as heavily tensioned as the ground warp, the cord 2 is raised and the beam-lever 5 lowered all the time to produce the extra tension necessary.

TERRY ORNAMENTATION

When simple terry weaves are used, such as those given in Fig. 397, the only possible form of ornamentation consists of introducing coloured pile threads to form stripes, but if the loops are formed on both sides of the cloth one side may be coloured independently of the other. In producing more elaborate ornamentation the pile yarns are caused to form loops first on one side and then on the other side of the cloth in the manner represented in Fig. 399. This system may be employed either with one or two series of pile threads, and styles be produced ranging from simple checks to complex figures. The principle of ornamentation, in which certain pile threads form loops while others lie straight in the cloth, cannot

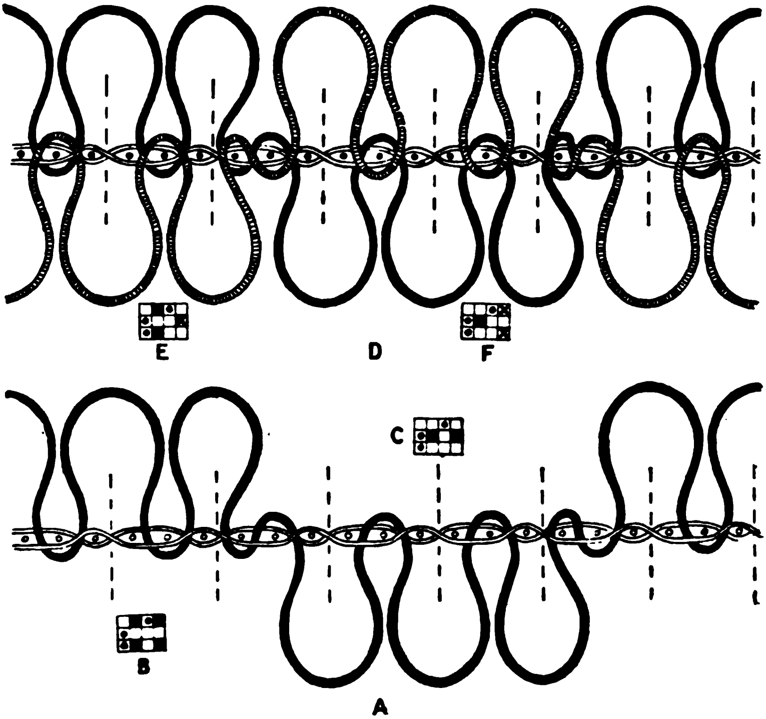


Fig. 399.

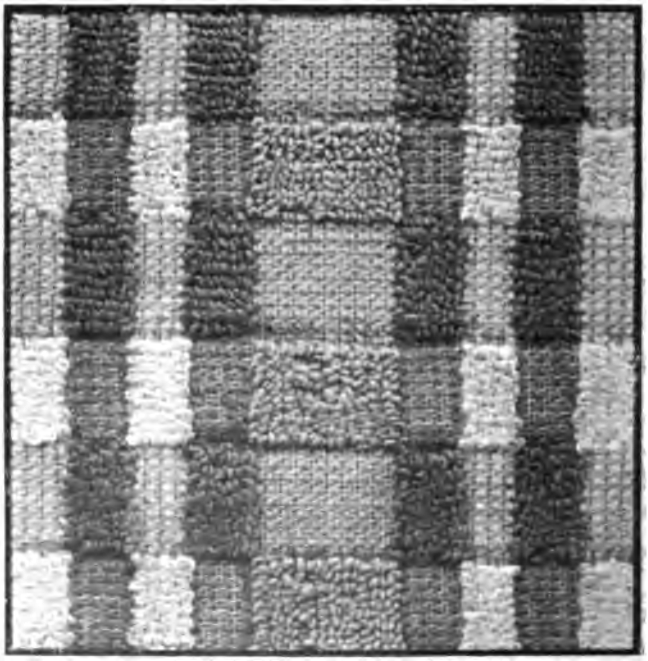


Fig. 400.

be employed, since all the pile yarn is brought from one warp beam, and it is, therefore, necessary for all the threads to form either pile or ground simultaneously.

When only one series of pile threads is used the pattern is due to the pile threads forming loops on the face and back in turn, so that alternate sections of pile and ground are produced on both sides of the cloth. In Fig. 399, diagram A illustrates this method of interlacing, while the weave design which forms the loops on the face is given at B, and on the back at C. In this system of ornamentation colours may be introduced either in the pile or in the foundation threads.

In Fig. 399 diagram D shows how the pile yarns interchange from face to back when two series are employed. In this case both sides of the cloth are covered by the loops, but one series of threads is differently coloured from the other series, so that alternate sections in different colours are formed. With the weave E, the loops are formed by the dark threads on the face and by the light threads on the back; and with the weave F they are formed by the light threads on the face, and the dark threads on the back.

Stripe and Check Dobby Patterns.—With dobby shedding simple reversible designs are obtained usually of a check character, and an example is given in Fig. 400, which shows an effect produced by a single series of pile threads, on the principle illustrated at A in Fig. 399. In this case, however, the threads are arranged in the order of 2 ground, 2 pile. The motive design of the cloth is shown divided into sections in Fig. 401. Sections G form pile on the face and ground on the back, and sections H form ground on the face and pile on the back. The drawing-in draft is shown at I and the lifting plan at J. In producing a given size of check, each section is repeated the required number of times.

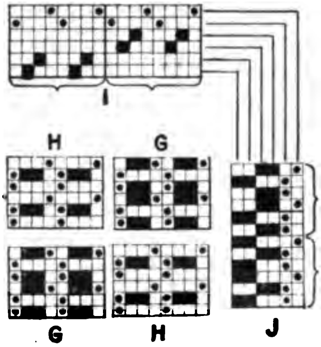


Fig. 401.

Fig. 402 shows a check pattern produced in two series of pile yarns, on the principle illustrated at D in Fig. 399. There is also a continuous stripe effect at each side of the check pattern. One series of pile threads is differently coloured from the other series, and in the corresponding design and draft given in Fig. 403, the black squares represent red pile while the crosses indicate white pile. Section K shows the weave used in producing the continuous stripe, while sections L and O form red loops on the face and white loops on the back, and sections M and N form white loops on the face and red loops on the back. The change of effect between sections L and M, and also between N and O, is due to a change in the weave. In the sections L and N, however, and also in sections M and O, the weave is exactly the same, the change of effect in this case being due to a change in the order of colouring. Thus, as indicated by the black squares and crosses respectively, the pile yarns in sections L and M are arranged 1 red, 1 white, and in N and O, 1 white, 1 red, two white pile threads coming together in the centre. The drawing-in draft is shown at P—three healds being used for the ground threads, and the lifting plan at Q.

The lower portion of Fig. 402 shows a cross-border, the bulk of which is formed by continuing the centre weave with the terry motion out of action, but there is also a heading produced by floating thick picks over seven threads. The weave design for the thick picks is shown at R in Fig. 403, the lifting plan being indicated at S. Three picks float on the face and then three on the back, in order that the border will be reversible similar to the centre.

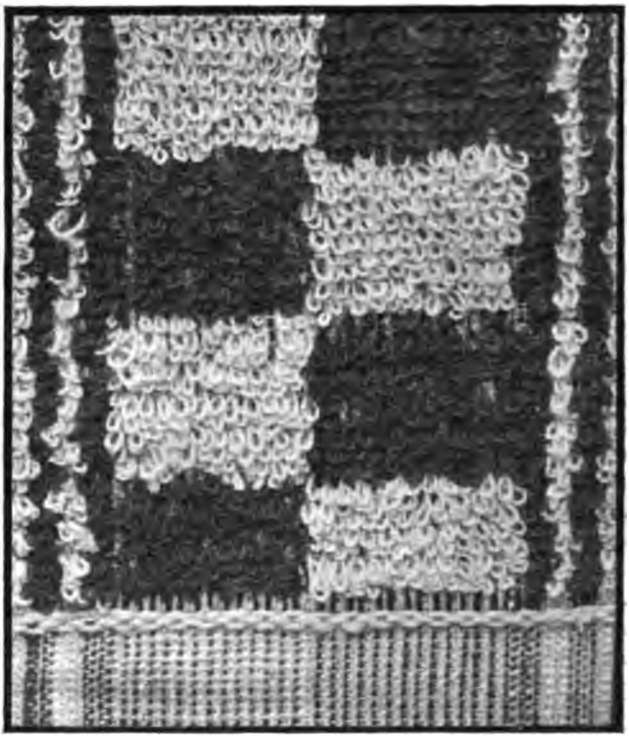


Fig. 402.

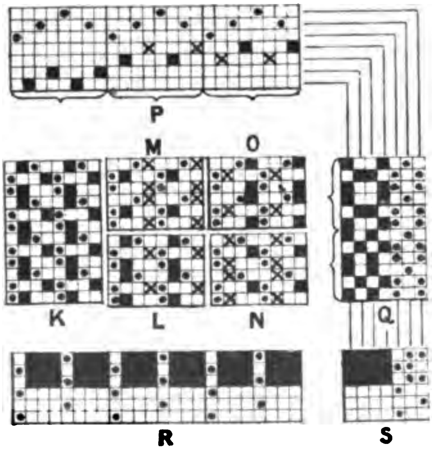


Fig. 403.

An interesting modification of the latter style of check pattern consists of separating the rectangular spaces from each other by narrow lines of ground, the longitudinal lines being formed by bringing about 6 or 8 threads consecutively from the ground warp beam, while the transverse lines are obtained by throwing the terry motion out of action for about 6 picks. This system of forming checks can also be employed when the pile threads are all of one colour, and when no interchange is made from one side of the cloth to the other.

Figured Terry Pile Fabrics.—A representation of a figured terry pile texture, taken from the corner of a bath mat, is given in Fig. 404. The example is simply an extension of the principle (illustrated at D, E, and F in Fig. 399 and in Figs. 402 and 403), in which two series of differently coloured pile threads are interchanged. In the fabric represented a figure in white terry pile is formed on a blue terry ground on one side of the cloth, and a blue terry figure on a white terry ground on the other side. The warp threads are arranged in the cloth in the order of 1 ground, 1 white pile, 1 ground, 1 blue pile, and the structure is a three-pick terry.

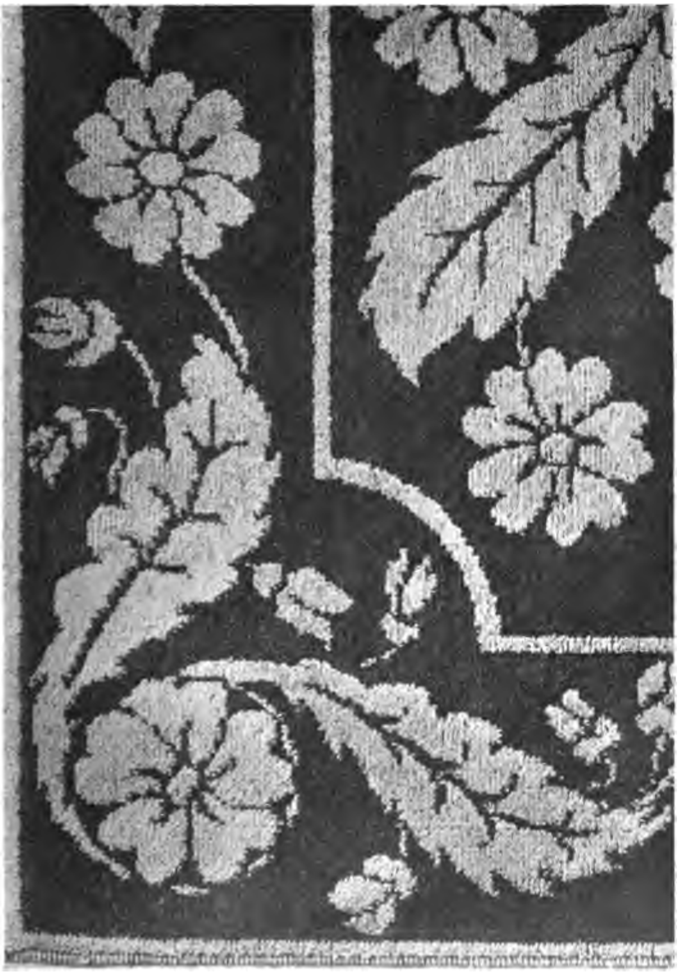


Fig. 404.

From an examination of the plans E and F in Fig. 399, and L and M, or N and O in Fig. 403, which represent opposite effects produced by two series of pile threads, it will be seen that one pile thread of each pair works exactly opposite to the other thread, while the ground threads are operated in the same regular order whichever thread is on the surface. A convenient system of shedding for figured fabrics, therefore, consists of an inverted hook jacquard and harness arrangement (as represented in Fig. 186, p. 161) combined with two or three healds placed behind the harness.

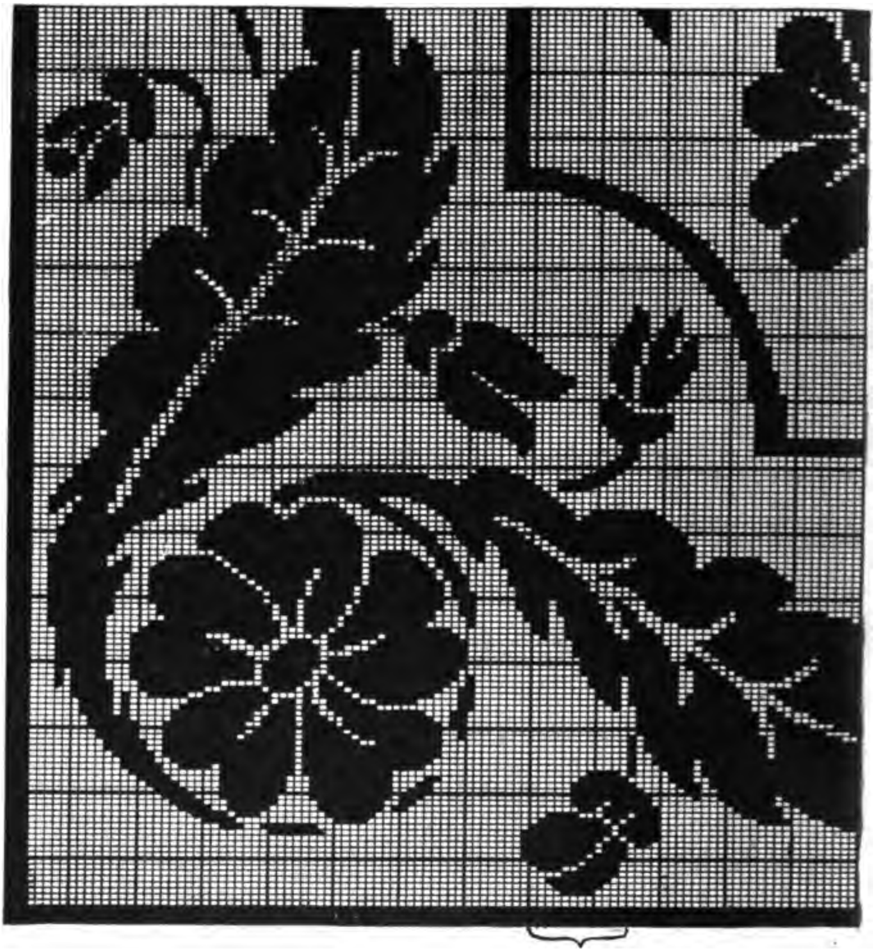


Fig. 405

With the mount described a figure is simply painted solid, as represented in Fig. 405, which corresponds with a portion of the design shown in Fig. 404. Each vertical space of the plan represents a pile thread of each colour, and each horizontal space a transverse row of loops or three picks. The cloth contains 56 warp threads per inch including the ground threads, and 58 picks per inch. There are, therefore, 14 pile threads of each colour per inch, and 19⅕ horizontal rows of loops per inch, so that for an 8-row jacquard the proper counts of design paper is 8 × 11, as shown in Fig. 405.

If the colour of warp that is required to form the figure is controlled by the hooks that are normally over the lifting knives in an inverted hook jacquard, three cards are cut from each horizontal space of the design shown in Fig. 405, as follows:—First card, cut the marks; second card, cut the blanks; third card, cut the marks. The sectional plans given in Fig. 406 correspond with a portion on 12 vertical and 16 horizontal spaces indicated by the bracket below the design in Fig. 405. The plan A shows the weave of the pile threads produced by the jacquard, the solid marks representing the lifts that are cut on the cards, and the crosses the opposite lifts that are formed by the inverted hooks. The weave of the ground threads, represented by the dots, is also included in the plan B, which thus shows the complete structure of the cloth. The horizontal marks at the side of A divide the picks into groups of three, on the last of which the reed is held firm in beating up. The odd pile threads form loops on the surface where the solid marks predominate in the plans A and B, and the even pile threads where the crosses predominate.

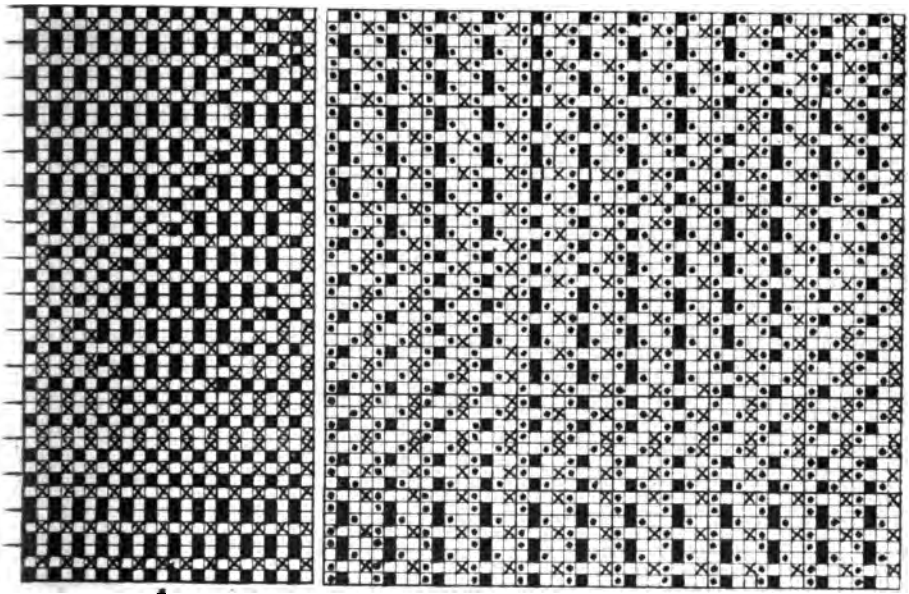


Fig. 406.

The system of designing, illustrated in Fig. 405, is suitable to employ for the class of figured terry cloths in which there is only one series of pile threads. In this case on one side a figure is formed in pile upon a ground of the foundation cloth, while on the other side the foundation forms the figure and the pile the ground. The principle is illustrated by the examples shown at A, B, and C in Fig. 399, and in Figs. 400 and 401. An ordinary form of jacquard and harness combined with healds may be employed, but the inverted hook arrangement, previously described, can be adapted to the purpose by casting out the harness cords that are controlled by the inverted hooks. The card-cutting particulars are as before.

Mixed Colour Effects.—In a further development of the Turkish towelling structure, which is applied to fancy household fabrics, such as antimacassars, mats, etc., white and two colours of pile warp are employed, and a design composed of four effects is produced. For instance, assuming that the pile threads are arranged 1 white, 1 pink, 1 white, and 1 green, the ground may be formed in white pile loops and the figure by mixtures of pink and green, white and pink, and white and green loops in the different sections of the design. There are really four series of pile threads in the cloth, two of which are on the surface and two on the back in every part.

A suitable shedding arrangement consists of a combination of healds with a jacquard and harness that is divided into four sections, as illustrated in the diagram given at A in Fig. 407. The first and third sections are allotted to the white pile threads of which there are two series, and the second and fourth sections to the pink and green threads respectively. The ground warp is drawn on two healds at the rear of the harness, and it will be seen that there are two pile threads, one of which is white and the other coloured, to each ground thread.

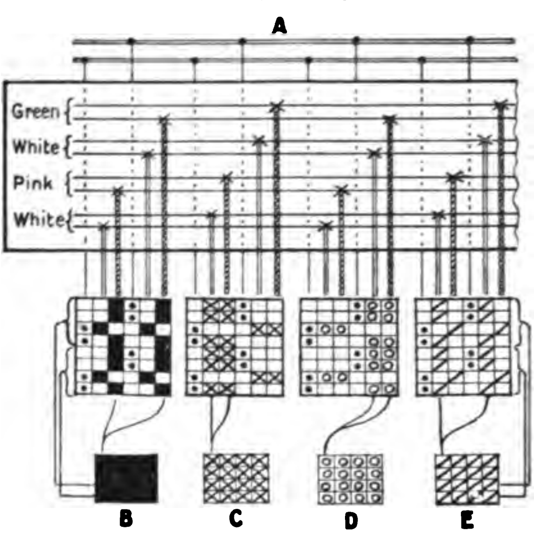


Fig. 407.

The system of mounting enables the four series of pile threads to be separately controlled by the cards, so that the different effects formed in the cloth can be indicated solid on the design paper, as represented at B, C, D, and E in Fig. 407. Each vertical space in the plan corresponds to four pile ends, and each horizontal space to a group of picks, in this case four as the structure is a four-pick terry. The plans B, C, D, and E are shown connected by lines with the corresponding complete weaves, and the vertical spaces in the latter coincide with the ends in the draft A to which they are joined. The basis of the structure is similar to that illustrated by the plan G in Fig. 397, except that the ground ends interweave in 3-and-1 order in G, and in 2-and-2 order in the weaves given in Fig. 407.

The plan B in Fig. 407 represents the pink and green pile threads on the surface, and all the white pile threads on the back; C, white and pink on the surface and white and green on the back; D, white and green on the surface and white and pink on the back; and E, all the white on the surface and pink and green on the back. The card-cutting particulars are as follows:—First, third, and fourth cards of each group of four—cut C and E on the first white section, B and C on the pink section, D and E on the second white section, and B and D on the green section. Second card—cut B and D on the first white section, D and and E on the pink section, B and C on the second white section, and C and E on the green section.

CHAPTER XVIII

WARP PILE FABRICS

Formation of Warp Pile—Form of the Pile Wires—Structure of Warp Pile. *Plain Warp Pile Fabrics*—All the Pile over each Wire—Two Picks to each Wire—Three Picks to each Wire—Fast Warp Pile Designing—Method of Heald Drafting—Four Picks to each Wire—One-half the Pile over each Wire—Backed and Double Foundation Cloths—Warp Pile Astrakhan Textures—Reversible Warp Pile Structures—Double Plush Weaving—Ornamentation of Plain Warp Pile Fabrics. Stripe and Check Designs.

Formation of Warp Pile.—In the manufacture of true warp pile structures only one kind of weft is essential, but two series of warp threads, separately tensioned, are required—viz., ground threads and pile threads; the former produce with the weft a foundation texture from which the pile threads project. The cloths are of two kinds—viz., looped pile, to which the terms terry, boucle, or frisé are applied; and cut pile, which is termed velvet. The " Turkish towelling " structure represents a class of looped or terry pile which, as previously shown, is conveniently and economically produced by means of a special reed motion and warp-easing arrangement. In the better classes of warp pile textures, however, such as dress and mantle fabrics, hangings, chair coverings, Brussels and Wilton carpets, etc., the pile is formed with the aid of wires. In this system a wire is inserted, instead of a pick of weft, in a special shed on which only those warp threads are raised that have to form the pile, the threads thus being looped over the wires. Subsequently the wires are withdrawn from the cloth, and the pile threads then project from the foundation either in the form of loops (forming uncut or terry pile) or in the form of tufts of fibres (forming cut or velvet pile), according to the kind of wire that is used. Compared with the terry towelling structure, the pile formed on the wire principle is much superior as regards both firmness and regularity; also there is greater scope for producing diversity of design. A cloth may have a perfectly uniform surface composed of either terry or cut pile, or the two structures may be used in combination, while one or both classes of pile may be used in conjunction with other weaves to form stripes, checks, spots, and elaborately figured styles. The ornamentation may also include the use of extra warp and weft. The looped pile structure, however, is not employed alone to a great extent except in the case of Brussels and tapestry pile carpets, in which diversity of colour is the predominant feature; its chief use in other textures is to produce variety of pattern in conjunction with cut pile or other effects.

The materials used vary according to the class of texture and the purpose for which the cloth is intended; mohair, lustre, demi-lustre, and cross-bred worsted, woollen spun silk, tussah or wild silk, and artificial silk yarns, are largely used for the pile. Cotton, flax, and wool are used for the weft, and cotton, flax, and jute for the ground warp.

Form of the Pile Wires.—The pile wires vary in shape according to whether they are to be inserted and withdrawn by mechanical means or by hand, and also according to whether the pile is to be looped or cut. A and B in Fig. 408 represent in front elevation and plan respectively the form of a cutting wire which is used in power weaving. The body of the wire is nearly rectangular, as shown (on an enlarged scale) in the cross-section given at C. One end of the wire is provided with a handle which is shaped for the reception of a hook, by means of which it is drawn longitudinally out of the cloth. The other end is in the form of a flat blade with a very sharp upper edge which cuts the pile threads as the wire is withdrawn; the twist then runs out of the free portions of the threads, so that tufts of fibres are formed. Shapes of looping wires are shown at D and G in Fig. 408, that are manipulated by power and hand respectively, a handle being provided in each case for the same purpose as in the power-cutting wire. If only a short looped pile is required the wires may be circular in cross-section as shown at E, and in order to prevent damage to the reed the extremity opposite to the handle is tapered towards the cloth. In producing a rather long pile the circular form is not suitable, because the number that can be inserted per inch is limited; hence flat wires are employed, as represented by the cross-sections F and H, which vary in thickness according to the number required per inch. A hand-cutting wire in front elevation, plan, and cross-section respectively is shown at I, J, and K; this wire is a split or double wire except at the ends, where the two portions are soldered together. Another form of hand-cutting wire is represented in cross-section at L, the wire in this case being solid except that a groove is formed in the upper edge. In cutting the pile a sharp blade, projecting from the underside of a small instrument termed a trevete, is inserted at one end between the wires or in the groove. The form of a trevete, as viewed from the side that during cutting is near the reed, is represented at M, and in plan at N. The cutting blade is shown at R, and S is a flange which serves to keep the instrument in position. Shallow recesses T and U are provided on opposite sides of the trevete, where it is gripped by two fingers and the thumb; it is slid along the upper edge of the wire, and cuts the pile threads in its passage by means of the blade, after which the wire may be lifted from the surface of the cloth.

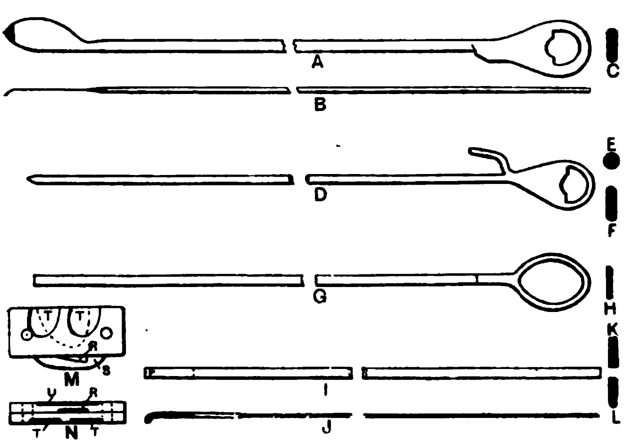


Fig. 408.

The length of the pile depends on the depth of the wire; common sizes are from $\frac{1}{16}$ to $\frac{1}{8}$ inch deep, but they vary in sizes of about $\frac{1}{32}$ inch difference to 1 inch deep and upwards. The very deep wires are employed for special fabrics, such as that represented in Fig 409, which are made in imitation of long-haired skins.

The pile warp during weaving takes up much more rapidly than the ground warp, the difference in length varying according to the depth of the wires and the frequency in which the pile threads are raised over the wires. In an ordinary plain pile structure the pile warp may require to be from five to twelve times the length of the ground warp. During weaving, in order that the pile face will not be injured, the temples act only on the selvages, and in winding the cloth on to the cloth beam the underside is brought in contact with the friction beam. When the pile is long, however, the cloth is not wound on to a beam, but is passed directly into a box or other receptacle.

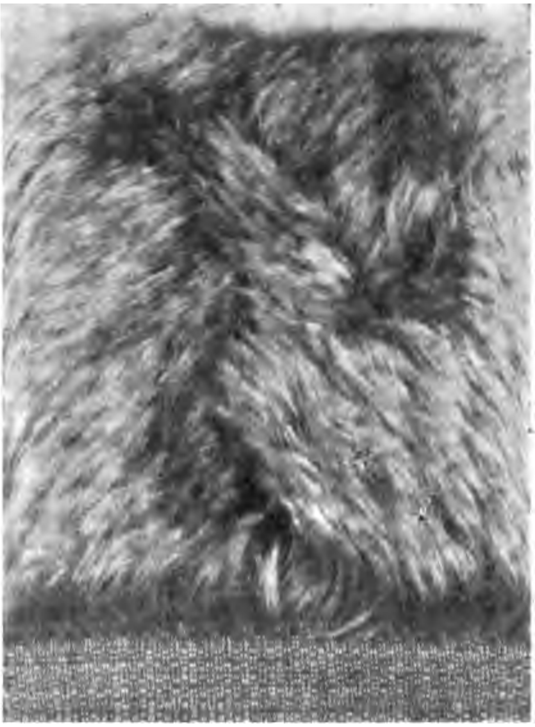


Fig. 409.

Structure of Warp Pile.—The diagrams F and G in Fig 410, which show sections through the weft, represent the formation of looped and cut pile respectively; in each case the position of the threads previous to and after the withdrawal of the wires is shown. Both examples might have been shown as looped, or both as cut pile, as the only essential difference in the manufacture of the two structures is in the form of the wire. (For this reason the two kinds of pile are considered together in the following.) At intervals of two, three, or more ground picks, a shed is formed in which only the threads that have to form pile are raised, and a wire is inserted which is beaten up to the fell of the cloth in the same manner as a pick of weft. Several wires are woven into the cloth before one is withdrawn in order that the tension on the pile warp will not cause the threads to slip out; then, as the foremost wire is withdrawn it is placed in the following pile shed. The operation is repeated throughout the length of the piece, a number of wires—usually not less than four—being constantly retained in the cloth.

The ratio of ground threads to pile threads, and picks to wires, may be varied to a considerable extent. In the plain pile structure the foundation weave is usually very simple, as it is completely concealed on the face side by the pile; plain, rib, and hopsack ground weaves are largely employed. In figured styles a ground weave may be arranged to suit a given ratio of the threads, or a ratio to suit a given ground weave.

PLAIN WARP PILE FABRICS

In addition to the divisions of looped and cut, or terry and velvet, the plain pile structures are technically classified in several ways, although they are all woven on the same general principle. One system of classification is according to the relative proportion of picks to wires, as two-pick, three-pick, four-pick, etc. In a second system they are divided into velvets for clothing and velvets for upholstery. In a third system the structures in which all the pile threads are over each wire are distinguished from those in which only half the pile is over each wire, the term velvet being applied to the former, and plush to the latter. Fourthly, the cloths are classified according to whether the pile threads are left down on the picks which precede and succeed a wire over which they are raised, or are passed over one or more picks next to the wire.

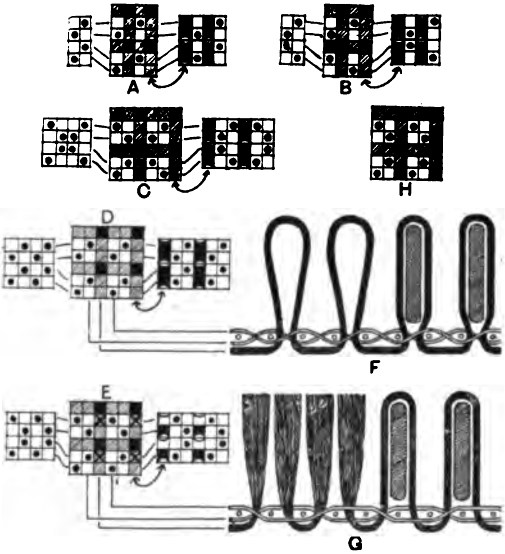


Fig. 410.

In the accompanying examples of plain pile designs the shaded squares indicate the positions of the pile threads and wire sheds; the full squares show where the pile threads are raised over the wires, and the crosses where they are raised over the picks, while the dots indicate the weave of the ground threads. In order that the examples may be readily analysed, the weave of the ground threads is shown separately on the left of each design, while on the right the complete weave, as viewed from the underside of the cloth, is given. In the latter it is assumed that the cloth is turned over horizontally; the dots show where the ground ends, and the full squares where the pile ends float on the back; but oval spaces are indicated between the squares to indicate the positions where the pile threads are passed over the wires on the right side of the cloth. It is necessary to keep in mind that the wires simply form the pile, and though separate warp sheds are made for them, they do not enter into the composition of the cloth.

All the Pile over each Wire—Two Picks to each Wire.—The designs A to E in Fig. 410 are arranged two picks to one wire, and all the pile threads are over each wire. In A and B there is one pile thread to each ground thread; in the former the ground threads form plain weave, and in the latter 2-and-2 warp rib. These examples are used only to a limited extent. The designs C, D, and E are arranged two ground threads to one pile thread, and the respective ground weaves are 2-and-2 hopsack, plain, and 2-and-2 warp rib. In each design A to D the pile threads pass under all the picks, but in E they are raised over the pick that precedes a wire. The drawings F and G, which respectively correspond with the designs D and E, will enable the two systems of construction to be compared. It will be seen that in F the centre of a wire rests over the space between two picks, and the pile threads pass under all the picks without interweaving with them. In G the wire rests above the pick that precedes the wire shed, and the pile threads interweave in plain order with the picks, so that there is less pile warp float on the underside of the cloth. This makes the pile less liable to be displaced by friction, hence the latter arrangement is more commonly used than the former; but in either system, if the pile is cut, the tufts are very liable to be disturbed or pulled out if friction is applied to the underside of the cloth. The plan H, which is a modification of E, shows the pile ends raised on the pick that succeeds a wire. This method is seldom employed; it is defective because the wires tend to lie at an angle, whereas with the interlacing shown at E they are held firmly in a vertical position.

Three Picks to Each Wire.—The examples I to M in Fig. 411 are arranged three picks to one wire, and two ground threads to one pile thread; all the pile threads are raised over each wire. The introduction of three picks between the wires enables the pile ends to be firmly bound into the foundation, so that a much faster and a more solid pile can be obtained than when there are only two picks to each wire (in cases where all the pile is brought over each wire). This will be seen by comparing N in Fig. 411 to F and G in Fig. 410. The plans I and J are similar, and both correspond with the drawing N; the latter represents the formation of looped pile, but it will be understood that the pile may be either looped or cut. The term "panne" velvet is applied to this structure. The difference between I and J is in the position of the 2-and-1 warp rib ground weave in relation to the pile interlacing. In I a pile end and the ground end on the right interlace with the weft in opposite order, whereas in J they work alike. In power weaving the wires are almost invariably withdrawn from left to right, which has a tendency to draw and lay the pile in that direction. This tendency is counteracted by making each pile thread cut with the ground thread on the right, hence the system of interlacing shown at I is more suitable for power wiring, while in forming cut pile that indicated at B is appropriate for hand wiring. Suitable weaving particulars are:—Pile warp, two-ply 60/2 spun silk; ground warp, 2/60's cotton; 72 ends per inch. Weft, 2/40's to 2/60's cotton, with from 48 picks and 16 wires per inch, to 90 picks and 30 wires per inch.

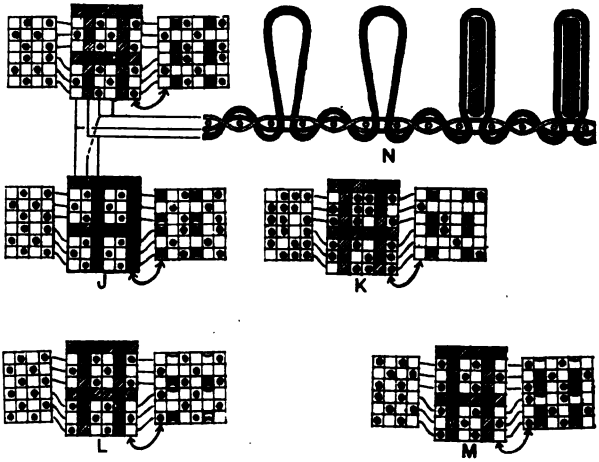


Fig. 411.

The plan K in Fig. 411 is a Lyons velvet in which the pile threads interlace in the same order as in I and J, but in this case the ground weave is based on the 3-and-1 warp twill, which, however, is modified to repeat on six picks by making the picks between which a wire is inserted in the same shed.

In the design L in Fig. 411 the pile threads are not firmly bound in as they are raised on the two picks which precede each wire; the foundation weave is plain. The design M is similar, the pile threads being raised on one pick preceding each wire, but the ground weave is 2-and-1 warp rib. This system of interlacing gives a fuller and loftier pile, and a softer and more pliable handle to the cloth. than when the pile is firmly bound in; and the designs L and M, although lacking in firmness, are largely used in the manufacture of very fine and rich silk velvets for clothing purposes.

Fast Warp Pile Designing.—The conditions that have to be observed in producing a good foundation and a fast pile are illustrated by the examples given in Fig. 412. which show the construction of a plain pile weave in stages. The threads are arranged three pile to one ground, and there are three picks to each wire; all the pile is brought over each wire. The system of interlacing is similar to that shown at N in Fig. 411. At A the positions of the pile threads and wires are indicated lightly, as shown by the shaded squares, and the lifts of the pile threads on the wire sheds are marked in, as shown by the full squares. At B the interlacing of the pile threads with the picks is illustrated; they are left down on the picks which precede and succeed a wire, and are raised on the centre pick, as shown by the crosses. For power weaving, the weave of the ground thread on the right of each pile thread is then inserted to cut with the marks of the pile thread. At C a weave is indicated on the remaining ground threads, which will form a natural connection with the marks already inserted; in order to ensure that an even foundation texture will result, the picks between which a wire is inserted should be in the same shed so that they will be readily beaten up close together. (It is for this reason that the 3-and-1 warp twill ground in the design K, Fig. 411, is made to repeat on six picks.) On the underside of the cloth, as shown in the plan on the right of C, the pile and ground threads form a foundation that is between hopsack and rib. The firmness of the foundation should always be considered, and the design D shows an alternative scheme of interlacing the ground threads which produces a firmer texture than C, as the pile and ground threads together form a 2-and-1 warp rib. By following the foregoing rules in constructing a pile weave a reliable structure will be formed so far as regards the interlacing of the threads, but many weaves are employed in which all the conditions are not present; and for some velvets, particularly those used for clothing purposes, they are not essential. In the two-pick cloths, when all the pile threads are over each wire, it is impossible to make the pile fast.

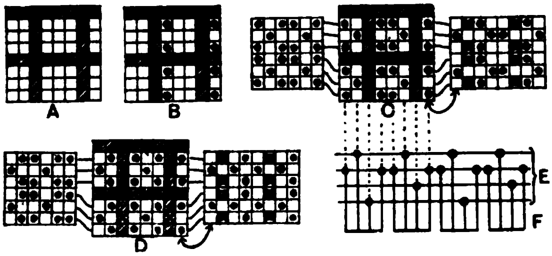


Fig. 412.

Method of Heald Drafting.—In drawing in the warp it is customary to draw the pile threads on the front healds, as represented at E in Fig. 412, which shows the draft of the plan C. The arrangement of the pile and ground threads largely determines the order of denting, as in each split of the reed it is necessary for the pile and ground threads to occupy the same relative position. This is ensured by placing each group of pile and ground threads in one split, as indicated at F.

Four Picks to Each Wire.—The examples G to K in Fig. 413 are arranged four picks to one wire, and two ground threads to one pile thread, with all the pile over each wire. The four-pick arrangement is not so commonly used as the styles with two and three picks to each wire. The construction of the designs G and H will be understood by comparing them with C and D in Fig. 412. In G the ground weave is 2-and-2 warp rib, and in H 3-and-1 warp rib; in both styles the ground and pile threads together form a foundation which is between hopsack and rib. The design I is a modification of H, in which the pile threads are firmly bound in, and are also raised on the pick which precedes each wire. In J the ground threads form 2-and-2 hopsack, and in K plain weave; the pile threads in the former are raised over two picks, and in the latter over three picks preceding each wire, this making it impossible to stitch the pile firmly into the foundation.

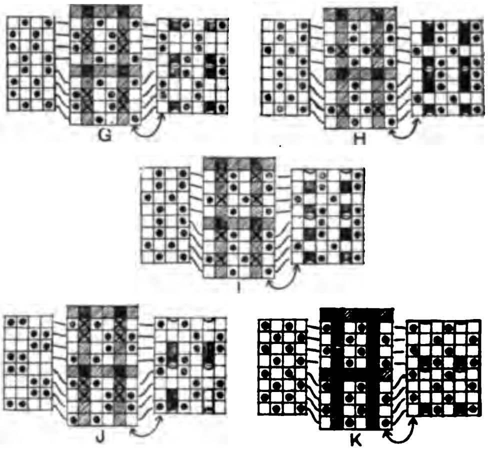


Fig. 413.

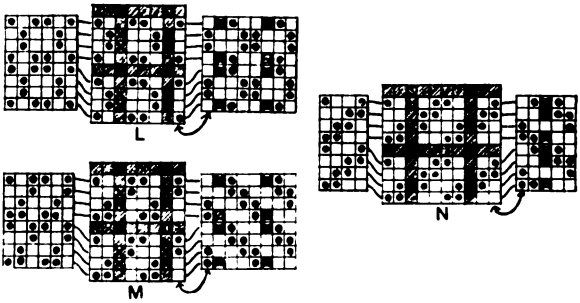


Fig. 414.

The designs L, M, and N in Fig. 414 are also arranged four picks to one wire with all the pile over each wire, but in L and M there are three ground threads to one pile thread, and in N four ground to one pile. In L the pile and ground threads together form a 2-and-2 hopsack foundation, and in M 2-and-2 twill; the weave of the ground and pile threads could also be arranged to form a 2-and-2 warp rib, or a 1-and-3 twill foundation. Such an arrangement, in which the pile interlacing forms a continuous weave in conjunction with the interlacing of the ground threads, is useful for styles in which a pile figure is formed on a simple weave ground, or *vice versa*, as the interweaving of the warp threads with the picks is the same throughout the cloth. The design N is also 2-and-2 twill ground, but in this case the pile threads are treated as extras, the stitching places occurring between ground warp floats. With this arrangement a pile figure might be formed on 2-and-2 twill ground with the pile threads firmly bound into the latter, but quite invisible from the face side of the cloth.

One-half the Pile over each Wire.—In the preceding examples all the pile threads are over each wire, so that distinct rows of loops or tufts are formed running in line with the weft. This can be readily seen when a piece of cloth is folded horizontally. In the examples given in Fig. 415 only half the pile threads are over each wire, so that the loops or tufts are arranged alternately, and the foundation cloth is more uniformly covered. This type of structure is largely used for upholstery fabrics, and also for silk plushes in which a cut pile is formed of greater length than is usual. All the pile warp may be brought from the same beam, but the weaving is facilitated by using separate slackening bars for the odd and even pile threads.

The designs A and B in Fig. 415 are alike, except that the former is arranged for hand-wiring, and the latter (in which it will be noted that the interweaving of each pile end cuts with the weave of the ground end on the right) for power-wiring. In both cases the threads interweave in the manner represented at C, the pile threads passing over the wires in alternate order. The threads in A and B are arranged in the proportion of one ground to one pile, and there are two picks to each wire—that is, there are four picks between the wires over which each pile thread is raised. The pile threads are firmly stitched into the foundation, and each is down on the picks that precede and succeed the wires over which it is raised, while the picks between which a wire is inserted are in the same shed. The term " Utrecht velvet " is applied to the structure. The weave of the ground threads is 2-and-2 warp rib, but the ground and pile weaves together form a 2-and-2 hopsack foundation. Suitable weaving particulars are :—Pile warp, 2/32's mohair ; ground warp, 2/20's cotton ; 64 threads per inch. Weft, 2/20's cotton ; 64 picks and 32 wires per inch.

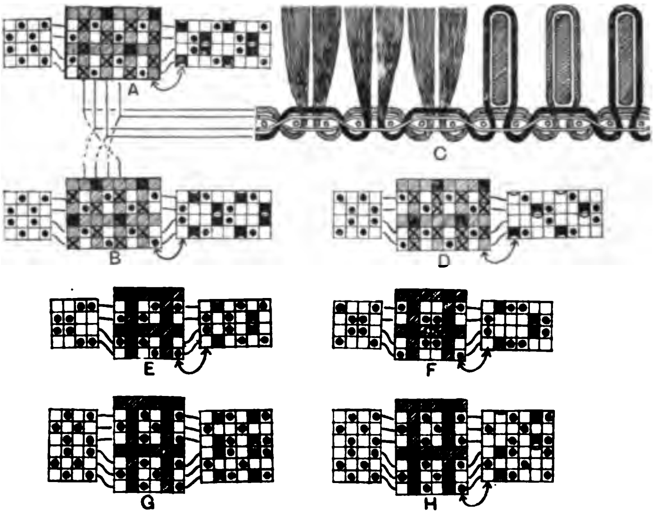


Fig. 415.

The design D in Fig. 415 is also arranged one ground to one pile, and two picks to one wire, and the ground weave is 2-and-2 warp rib. In this case, however, the pile threads are not firmly stitched into the foundation, as each is raised over three picks preceding the wire over which it is passed. A very full, soft, and lofty pile results, which, however, readily frays out if friction is applied to the underside of the cloth.

In the designs E and F in Fig. 415 there are two ground threads to each pile thread, and two picks to each wire; the threads interlace in a similar manner to the example shown at C. In both E and F the weave of the ground threads is 2-and-2 hopsack, which, however, is arranged in different positions in relation to the pile interlacing, with the result that the complete foundation weave of E is 2-and-2 warp rib, and of F 3-and-2 hopsack; the former foundation being much firmer than the latter.

The designs G and H in Fig. 415 are arranged three picks to one wire, and in each case the pile threads are firmly bound in with as little float on the back as possible. In G each pile thread is down on the picks that precede and succeed the wire over which it is raised, but in H each is raised on the three picks preceding the wire.

Backed and Double Foundation Cloths.—In fabrics in which the pile threads are not firmly stitched in, the liability of the pile being disturbed by friction may be almost entirely eliminated by making the cloths backed or double. Also, in cases where the cloth is raised on the under side in order to increase its softness and warmth, such an arrangement is useful, as the pile floats on the back are concealed by the additional threads, and are, therefore, not acted upon in the raising process. The design I in Fig. 416 shows a modification of E in Fig. 415 in which the pile threads are not firmly bound in; and an additional (backing) warp thread is introduced on each side of each pile thread where indicated by the arrows. The additional threads are interwoven as shown by the diagonal marks; on the underside (as shown on the right of I) they have a float of three between which the pile threads are woven into the foundation and concealed.

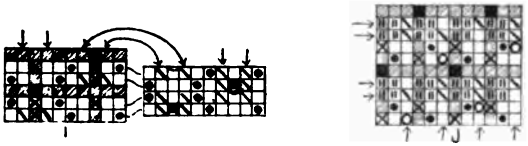


Fig. 416.

The design J in Fig. 416 shows a double cloth style which is suitable for a raised finish on the underside. The face texture exactly corresponds to the design B in Fig. 415, but additional warp and weft threads are introduced (where indicated by the arrows) which form a cloth with a four-thread weft sateen surface on the underside. In the design the full squares represent the pile threads raised over the wires, and the crosses the same threads raised over the picks; the dots show where the face ends pass over the face ground picks, the diagonal marks where the backing ends pass over the backing picks, the circles where the backing ends pass over the face picks in order to stitch the back cloth to the face, and the double vertical marks where the ends of the face texture are raised on the backing picks.

Warp Pile Astrakhan Textures.—The designs given in Fig. 417 are used for warp pile Astrakhan structures, the typical curly appearance of which is enhanced by using for the pile warp thick worsted yarn which has been subjected to a boiling process while wound round spindles or twitched tightly in the hank. The pile threads are usually raised alternately on the wire sheds, and in most cases are lifted on several picks preceding, as shown at A and B ; but they are always firmly bound into the foundation. The design C shows a modification in which the pile threads are raised over the wires in 4-sateen order. In the design D the odd pile threads are raised over all the wires, while the even threads are raised alternately ; by having the former in finer yarn than the latter, and bringing the two series from separate beams, different heights of pile are obtained. Generally, the Astrakhan structure is made in looped pile ; the design E shows how both cut and looped may be combined in the same cloth, by using one kind of wire on the sheds in which the circles are indicated, and the other kind where the full squares are inserted.

Reversible Warp Pile Structures.—Warp pile cloths that are to be used as hangings are sometimes made with a cut pile on both sides. A method of accomplishing this is illustrated at A in Fig. 418, and the corresponding section given at B, which shows how the warp threads interlace. Half the pile is over each wire, and in this case, after the insertion of a wire, an extra pick is introduced on which all the ground ends are raised (as shown by the diagonal marks in A), and alternate pile ends. In the section B the extra picks are indicated below the level of the plain ground threads, while one pile thread is shown shaded and the other solid in order that the system of interlacing may be readily seen. Exact repeats of the weave are indicated by the brackets, the portion lettered C representing the cloth previous to, and D following, the withdrawal of the wires. After the cloth is woven, the extra picks, which are usually thicker than the ground picks, are drawn away from the underside of the cloth ; this causes one-half of each double tuft to pass to the reverse side, as shown in the section E, where the dotted circles indicate the positions which the extra picks previously occupied.

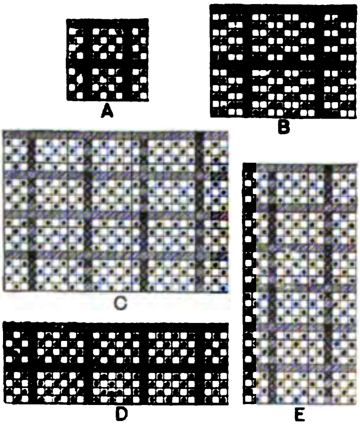


Fig. 417.

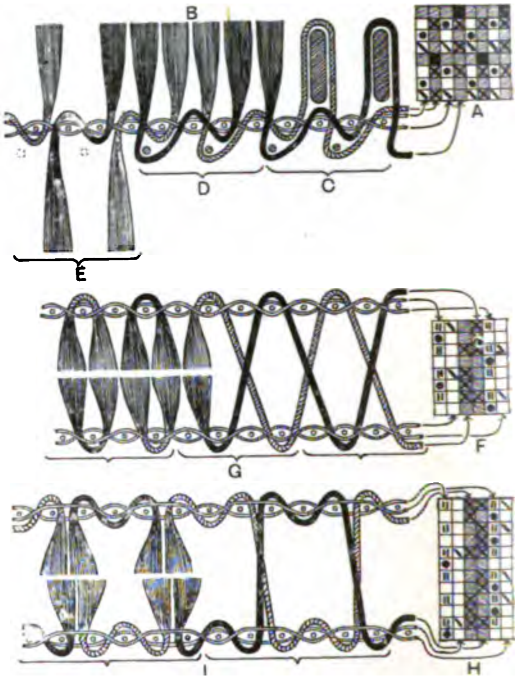


Fig. 418.

Double Plush Weaving.—The plans F and H and the corresponding sections

G and I in Fig. 418 show two methods of interlacing the threads in "double plush" weaving, in which, without the use of wires, two separate cut warp pile fabrics are produced at the same time. This system is employed to a considerable extent, as the production of a loom is much greater than when wires are used; but the pile is less regular, and a long pile cannot be obtained. Each cloth has a distinct series of ground warp and weft threads; the pile threads are common to both cloths, and pass from one to the other, as shown on the right of G and I. As the weaving proceeds the pile threads are cut by means of a knife which is run horizontally between the cloths, the pile being formed on the lower side of the upper cloth, and on the upper side of the lower cloth, as shown on the left of the drawings. In each case the brackets indicate exact repeats of the weave; in F and G the ground weave is plain, and in H and I, 2-and-1 warp rib. In the latter each pile tuft is firmly bound into the foundation.

Ornamentation of Plain Warp Pile Fabrics. — After weaving, the plain pile structures are ornamented in various ways. An imitation of Astrakhan is obtained in the plain Utrecht structure by tieing the cloth tightly with twine while it is in a crumpled condition, and boiling it in water. The pile surface may be figured by printing, or embossed effects be produced by submitting the cloth to the pressure of engraved rollers. In the latter method the pile, where the figure is required, may be pressed down, while that in the ground sections, which stands vertically from the foundation, is partially cut away. The flattened pile is then raised, with the result that a distinct pile figure is formed. An illustration of this style is given in Fig. 419, in which the arrangement of the threads and the system of interlacing correspond with the example shown at I in Fig. 416.

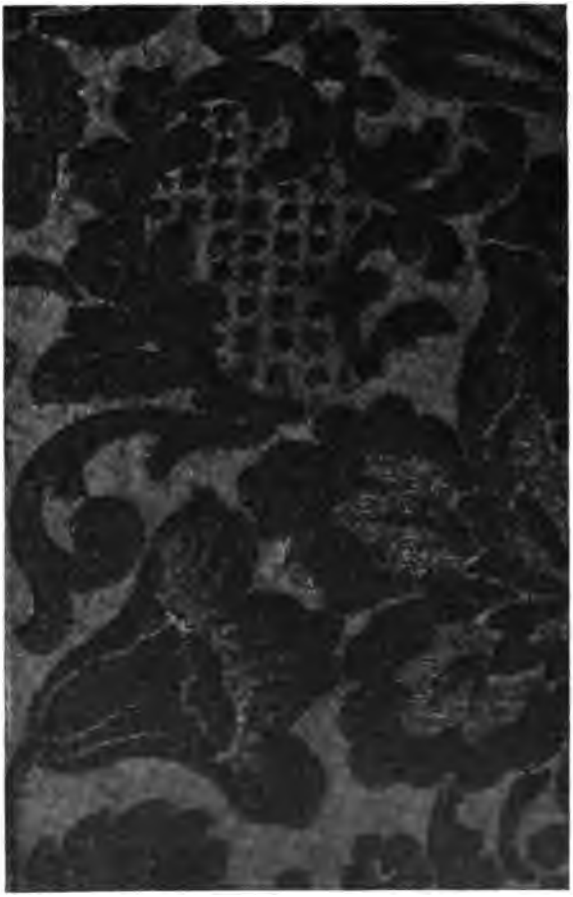


Fig. 419.

A design may also be produced, as in tapestry pile carpets (see p. 437), by printing—previous to the weaving operation—a figure on the pile yarn in an elongated form, the degree of elongation varying according to the amount of contraction of the pile threads.

During manufacture, the plain structures may be ornamented by introducing differently coloured pile threads so that stripes are formed ; while a check appearance may be given to the cloth, as shown in the fabric represented in Fig. 420, by afterwards pressing down the pile in transverse bars. This is an illustration of a silk plush fabric, the structure of which corresponds to the example given at D in Fig. 415.

A variation in the structure may be produced by employing both cutting and

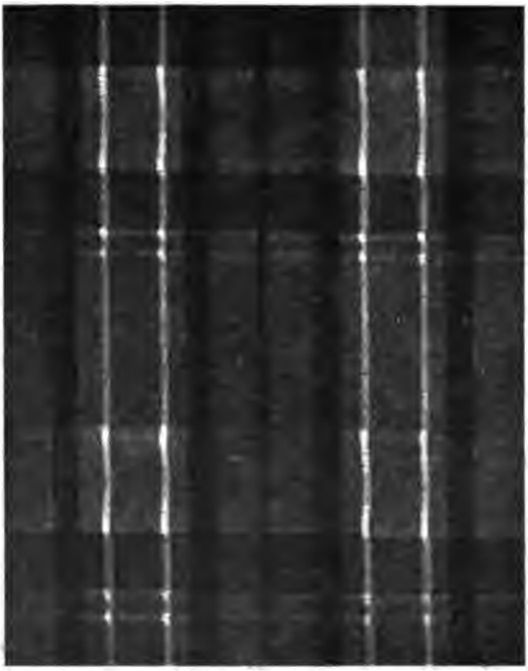


Fig. 420.

looping wires, or by using two different heights of wires ; whilst both systems may be employed in conjunction with differently coloured pile threads. Thus, in the examples A, B, and C in Fig. 421, the differently shaded spaces indicate—horizontally –different forms of wires and—vertically—different colours of pile warp. In A and B the full squares may represent cut pile in one colour, and the circles looped pile in another colour ; or one colour may be developed in a longer pile than the other. In C each colour of pile is developed in two ways, as, for instance, the full squares may indicate cut pile and the circles looped pile in one colour, and the horizontal and vertical strokes cut and looped pile respectively in the other colour. Stripes of cut and looped pile, in one or more colours, may be produced in the manner shown at D, in which the brackets denote the different sections. The structure in each section corresponds to the example given at I and N in Fig. 411.

Stripe and Check Designs.—A form of ornamentation obtained without having recourse to a jacquard machine consists of combining the pile structure with other forms of interlacing in stripe and check form. The design E in Fig. 421 is an illustration of a stripe composed of pile and 2-and-2 warp rib. The pile interlacing corresponds with E and G in Fig. 410, while the rib stripe is simply a continuation of the weave of the ground threads, and can, therefore, be produced by the same healds. Different widths of stripes can be obtained by repeating the sections enclosed by brackets.

The design F illustrates the formation of alternate squares of pile on a warp rib ground, with longitudinal spaces of ground between, which may be coloured different from the pile sections. There are two picks to each wire, and the warp is arranged 1 worsted ground, 1 worsted pile, and 1 cotton; the worsted threads work in pairs except on the wire sheds, in order to develop the rib formation. The rib structure is made more pronounced by weaving the cotton ground threads at greater tension than the worsted ground threads, and by wefting one pick fine, one pick coarse. Four warp beams are necessary — viz., two for the pile threads and one each for the worsted and cotton ground threads, while six shafts are required, as shown in the draft indicated at G.

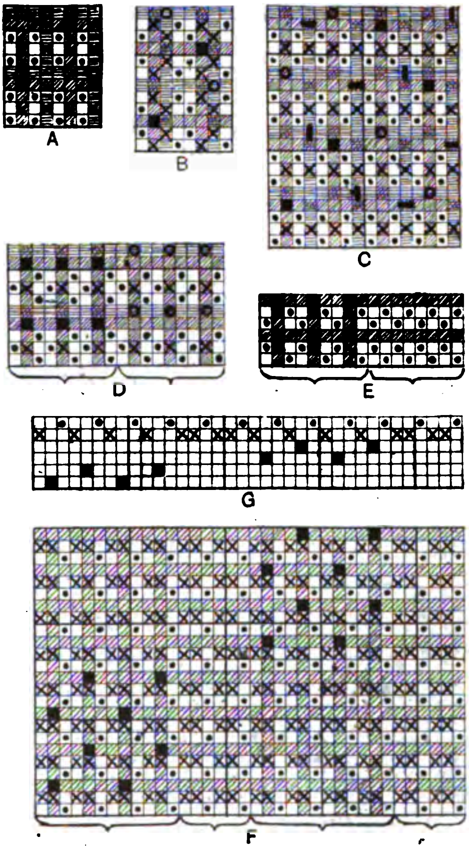


Fig. 421.

CHAPTER XIX

FIGURED WARP PILE FABRICS

Figuring with Cut and Looped Pile. Warp Pile Figuring on Ordinary Weave Grounds—**Pile Figuring with Extra Threads—Figuring with Pile Threads which interweave in the Ground—Combinations of Pile and Figured Warp Rib.** *Combinations of Pile and Double Plain Cloth. Combination of Pile and Weft Figure. Looped Pile and Warp Rib Figure on Cut Pile Ground.*

FIGURING WITH CUT AND LOOPED PILE

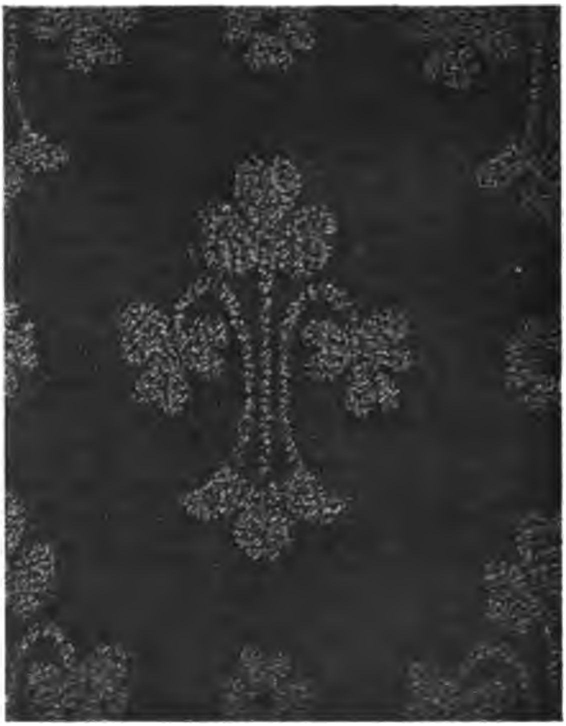


Fig. 422.

This type of structure, an illustration of which is given in Fig. 422, is largely used for upholstery purposes, the ground warp being composed of cotton or linen, the weft of cotton, and the pile warp of worsted. There is only one series of pile threads, but each thread forms either cut or looped pile continuously, so that the surface of the foundation is entirely covered by the pile—the cut and loop structures alternating according to the form of the design. In order to provide a suitable background to the pile the ground warp and weft are generally dyed before weaving, whereas the pile yarn is woven in the grey or natural state, and is dyed in the piece. Although subjected to the same dye, there is such a difference in the reflection of the light from the looped and cut pile surfaces that one appears quite distinct from the other. The looped pile, which generally forms the figure, reflects the light more directly to the eye of the observer, and appears lighter and brighter than the cut pile ; the rays of light penetrate more readily in the cut pile sections and become saturated with the colour, and when they are reflected they are dispersed in all directions by the innumerable points of the fibres, so that the colour appears deep and rich.

The structure of the cloth, shown in Fig. 422, corresponds to the example given at B and C in Fig. 415, except that both a cutting and a looping wire are introduced after the insertion of each pair of ground picks. The following are suitable weaving particulars :—Pile warp, 2/30's worsted ; ground warp, 22's linen ; 32 pile and 32 ground ends per inch ; weft, 15's cotton ; 64 picks, 32 cutting, and 32 looping wires per inch ; depth of wires, $\frac{1}{8}$ inch. The pile warp requires to be from five to six times as long as the ground warp. As shown in the draft given at A in Fig. 423, the ground ends are operated by healds placed behind the harness ; the latter, on which the pile ends are drawn, is placed as near the fell of the cloth as possible. A convenient method of indicating a design is illustrated at B in Fig. 423, which shows a portion of the effect given in Fig. 422. Each vertical space in B represents a pile thread, and each horizontal space, four sheds—viz., two sheds for the ground picks, one shed for a cutting wire, and one shed for a looping wire. The counts of the design paper is, therefore, based upon the proportion of pile threads per inch to wires of each kind per inch, or with the foregoing particulars as 32 : 32 = 8 × 8 design paper.

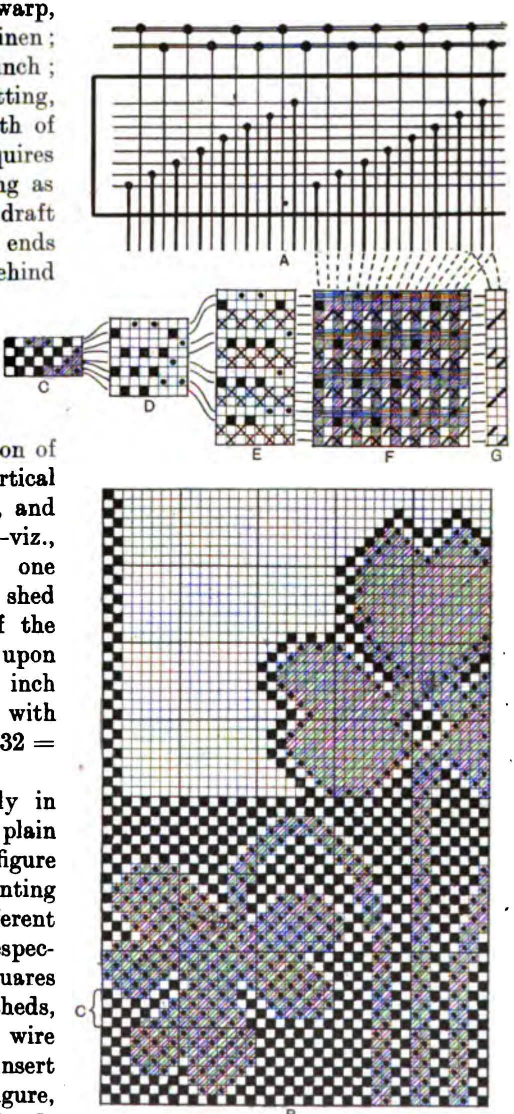


Fig. 423.

The figure is indicated lightly in colour on the design paper ; then plain weave is inserted on both the figure and the ground, the marks representing the lifts of the pile threads. Different marks, however, are used for the respective sections ; thus, in B the full squares represent lifts on the cutting wire sheds, and the dots lifts on the looping wire sheds. It is generally sufficient to insert the plain weave at the edges of the figure, as shown in the upper portion of B. It is an advantage to indicate lifts, as when a narrow line of an effect is required it can be seen that the proper marks are inserted to make the line continuous and of sufficient prominence. One-half the pile threads are raised on one pair of wires (those required up for a cutting wire being left down for a looping wire, and *vice versa*) and the other half on the following pair. Therefore, so long as both kinds of wires are of the same depth, the take-up of the pile warp is uniform, and all the pile threads may be brought from one beam.

The gradual development from the design to the complete structure is illustrated at C, D, E, and F in Fig. 423. C corresponds with the bracketed portion on the left of B ; D shows how the figuring cards alternate, the full squares in each horizontal space of C being cut on the first card and the dots on the second ; E shows the full effect produced by the jacquard, two plain cards for the ground picks being introduced between the pairs of figuring cards ; and F shows the complete structure produced by the combined action of the jacquard and healds, the latter being raised alternately on each pair of ground picks, as indicated at G.

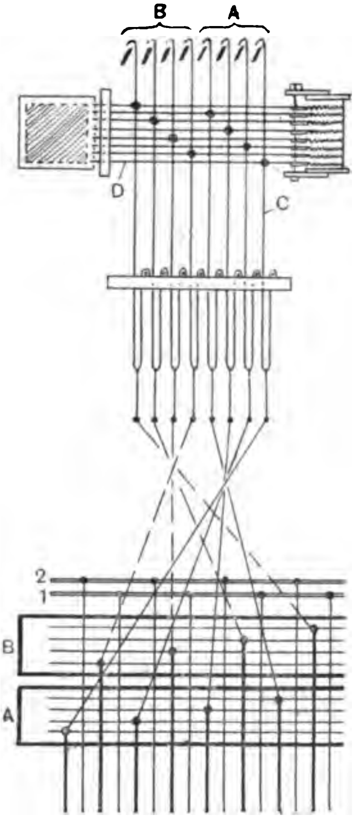


Fig. 424.

A great saving in cards may be effected by mounting the harness on the knotted comber-board principle, with the tie arranged as shown in Fig. 424, as the plain cards, which in an ordinary mounting are used to raise the pile threads on the ground picks, may be dispensed with. The draft of the warp threads is represented in the lower portion of Fig. 424, and in the upper portion the hooks C are shown specially connected with the needles D ; lines indicate how the knotted harness cords pass from the neck cords to the separate comber-boards A and B. The odd pile threads are drawn on the harness cords which pass through the comber-board A, and are controlled by the odd needles ; while the even pile threads are drawn on the cords which pass through the comber-board B, and are controlled by the even needles. With this arrangement the designing is the same as for an ordinary machine, and the harness cords are perfectly straight when the card cylinder is at the front or back of the jacquard. On one ground pick of each pair the board A and the heald No. 1 are raised by means of tappets, and on the other ground pick the comber-board B and the heald No. 2, during which the jacquard is stationary. The comber-board and the healds are then stationary while the jacquard lifts the pile threads on the cutting and the looping wire sheds in succession.

WARP PILE FIGURING ON ORDINARY WEAVE GROUNDS

In these styles the pile threads are not forming pile all the time, and the amount of take-up of the threads varies. It is, therefore, necessary for each pile thread in the repeat of a design to be run off a separate bobbin ; each bobbin may carry as many threads as there are repeats of the design in the width of the fabric.

In some cases the bobbins are supported in a vertical creel placed at the rear of the loom ; but in weaving fine silk plushes, for which small bobbins are employed, they may be placed in a horizontal frame, fixed underneath the ground warp. Each bobbin is so constructed that a cord and weight may be connected to it to give the required tension.

Pile Figuring with Extra Threads.—Fig. 425 illustrates a cloth in which a cut pile figure (similar in structure to the example given at E and G in Fig. 410, p. 398) is formed on a check foundation. The pile threads are extra, and, where not forming pile, float loosely on the back of the cloth, from which they are afterwards brushed away. At the upper and lower edges of a figure one-half of each double tuft is, therefore, removed from the surface of the cloth ; a feature which requires to be taken into account in drafting a design, although in the case of a massive figure it is not of much importance. The ground ends work in 2-and-2 order with the picks throughout, hence a heald-and-harness draft, as indicated at A in Fig. 426, may be employed. All the pile threads are over each wire ; therefore, in indicating a figure on design paper it is marked solid, as shown at B in Fig. 426. The complete structure of the first 16 ends and 8 picks of B is given at C, in which it will be seen that there are two ground threads to each pile thread, and two picks to each wire ; while where the figure is formed the pile threads are raised on the pick which precedes a wire. If an ordinary jacquard is employed a separate card is required for each shed, so that each horizontal space of B represents three cards. On the first ground pick all the pile threads are left down, a blank card being used ; on the second ground pick and the wire shed following,

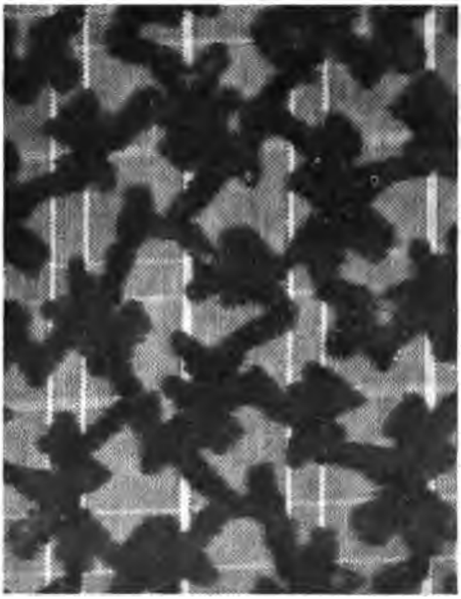


Fig. 425.

the pile threads are raised where the figure is formed, hence the marks of the design are cut the same on two successive cards. One figure card will serve for the three sheds, however, if the jacquard is driven by means of a tappet which makes one revolution for every three revolutions of the crank shaft, and if the tappet is so

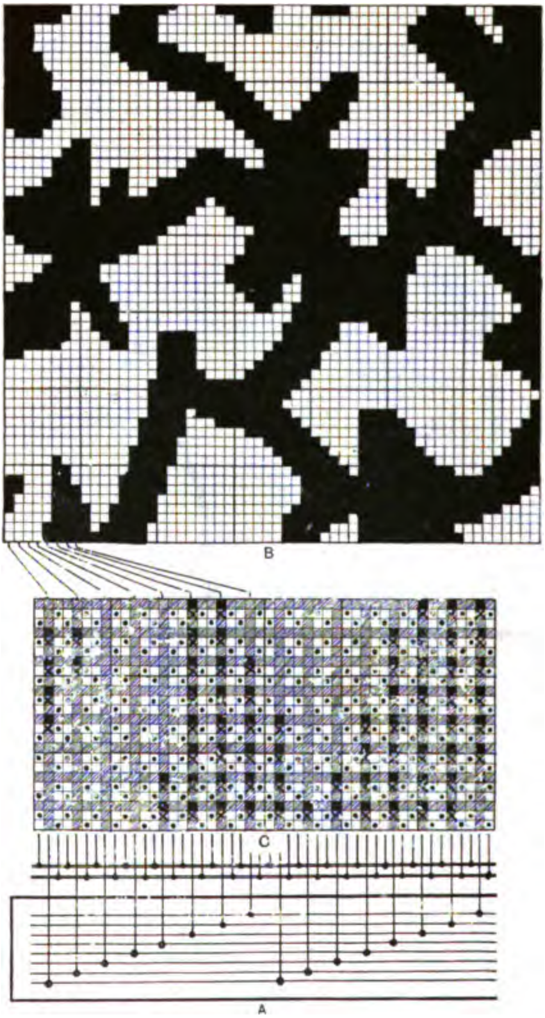


Fig. 426.

shaped that the griffe is lowered on the first ground pick and raised on the second ground pick and the wire shed following.

The foundation texture may be varied in the 2-and-2 warp rib ground weave by the way in which the warp and weft threads are balanced. In the example represented in Fig. 425 there are nearly twice as many picks as ground ends per inch, and the weft is finer than the warp, so that the texture appears like plain cloth, and the ground warp and weft colours are about equally prominent. On the other hand, if more ends than picks per inch, and finer warp than weft, were employed, a pronounced warp rib ground texture would be formed which, while concealing the weft, would bring a lustrous ground warp prominently to the surface.

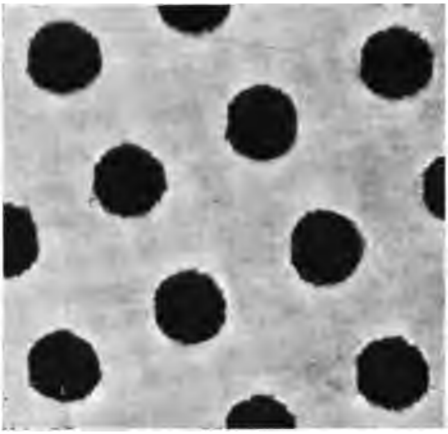


Fig. 427.

In the cloth represented in Fig. 427, extra warp spots in cut pile are formed on a warp sateen ground texture, from the underside of which the surplus threads are removed where they are not required to form the figure. In the warp there

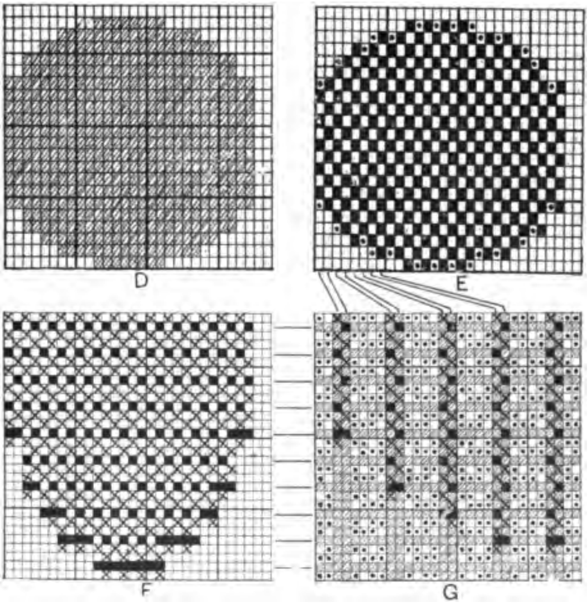


Fig. 428.

are four ground threads to two pile threads, and two picks are inserted to each wire. The ground ends, which interweave in 4-warp sateen order in both the ground and under the figure, may be operated by four healds placed behind the harness; therefore, in the designing it is only necessary to consider the figure. The form of a spot is indicated at D in Fig. 428, the pile threads being shown in pairs; while E shows a corresponding form ready for the card-cutting, the marks representing the lifts of the pile threads. The alternate pile threads only are raised over each wire, hence plain weave is inserted over the figure, as shown by the full squares. At the upper and lower edges, however, additional marks are put in, as shown by the dots, in order that all the threads will be raised at these places

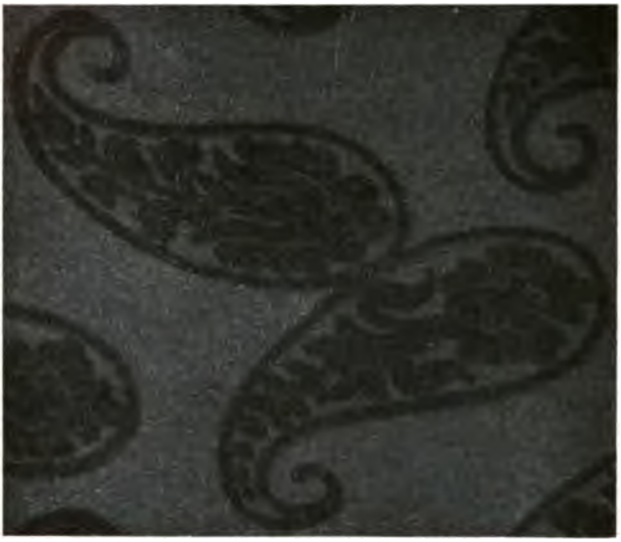


Fig. 429

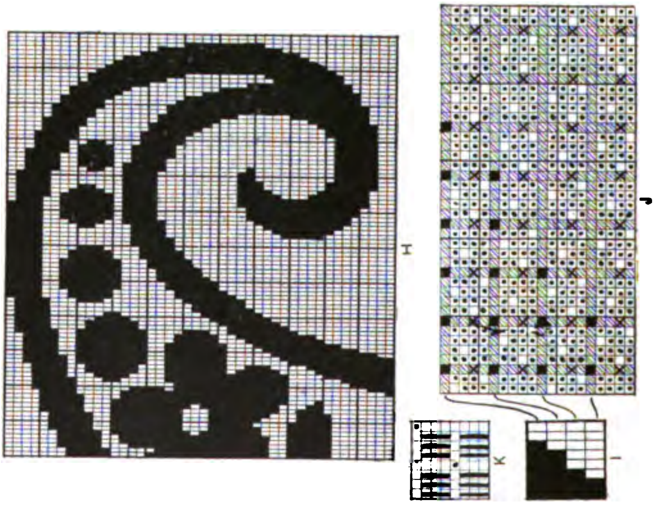


Fig. 430.

and thus compensate for the removal of the tufts, which, in this structure, would otherwise make the edges of the figure appear thin.

Each horizontal space of the plan E represents two picks and a wire, and three cards are cut from each as follows:—For the wire shed, cut the marks of the figure; for the weft sheds, cut the figure except where the full squares are inserted—two cards alike, one of which is placed before, and the other after the wire card. A portion of the pile effect, as cut on the cards, is shown at F, while G repiesents the complete structure of the first 10 threads of F, including the ground threads.

In the example represented in Fig. 429, the pile threads are extra, but in this case they are bound in on the back of the cloth. The ground weave is 8-thread warp sateen throughout, and the threads are arranged four ground to each pile, and four picks to each wire, to fit with the repeat of the sateen weave. Where the figure is formed, all the pile is brought over each wire, and as the pile threads may be operated by eight healds placed behind the harness the figure is designed solid, as shown at H in Fig. 430. Each horizontal space of H represents five cards—viz., three blank cards for the first, third, and fourth picks; one card all cut for the second pick, on which the pile threads are bound in; and one card for the wire on which the marks of the figure are cut. A sectional plan is given at I, and the corresponding effect at J, which illustrate the development from the solid design to the complete structure of the cloth, including the weave put in by the healds. The pile threads, each of which is composed of three threads, are stitched on the back of the cloth in 3-and-1 order. The warp is very finely set, and the pile threads spread out and cover the underside of the foundation texture, which, therefore, has the appearance of a warp rib, similar to the effect shown at K.

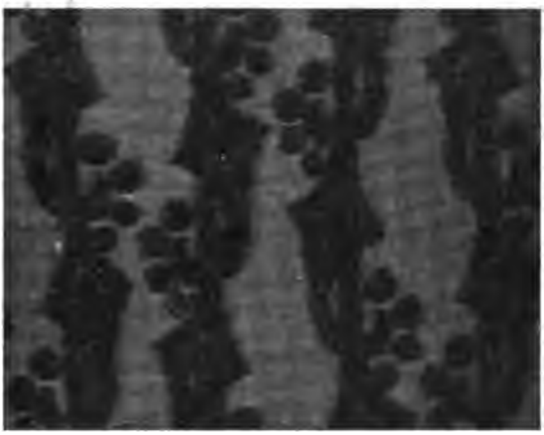


Fig. 431.

When the pile threads only are operated by the harness, the counts of the design paper is in the proportion of the pile threads per inch to the wires per inch. Thus, for the cloth illustrated in Fig. 429, which has 280 ground and 70 pile threads per inch, and 128 picks and 32 wires per inch, the counts of the design paper is in the proportion of 70 to 32, or 8 × 4 nearly.

Figuring with Pile Threads which Interweave in the Ground.—In the cloth illustrated in Fig. 431 the pile threads are not extra; they form figure, and then interweave in the foundation in the same manner as the ground threads. The latter are black cotton, and the pile threads black worsted, while the weft is coloured mercerised cotton. There are three ground threads to each pile thread, and three picks to each wire; and the cloth contains 136 ends and 81 picks per inch. In the pile figure the weave is as shown at A in Fig. 432 (which corresponds with the example given at D in Fig. 412, p. 400), and in the ground as indicated at B. The weft sateen weave in the ground covers the warp, so that a black worsted

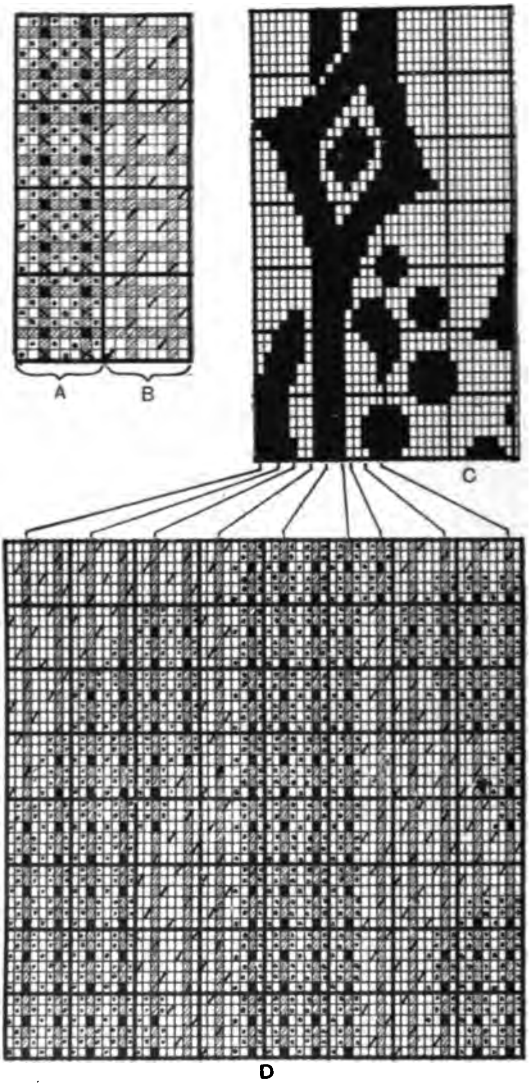


Fig. 432.

pile figure is formed on a coloured cotton foundation. As the weave of the ends is different in the pile and ground sections it is necessary for all the warp to be controlled by a jacquard. A figure may, however, be first designed solid, as shown at C in Fig. 432, which corresponds with a portion of the effect given in Fig. 431; the counts of the design paper is in the proportion of 136 ÷ 4 to 81 ÷ 3, or 8 × 6 paper. The full plan for the card-cutting may then be readily constructed, each vertical space of C representing four threads, and each horizontal space three picks and one wire. It is, however, unnecessary to include the wire sheds in the enlarged plan (which only makes the insertion of the sateen ground weave more difficult), as these lifts may be indicated by using a special kind of mark to represent where the pile threads are raised over the weft in the figure. Thus, in D, Fig. 432, which shows the card-cutting plan of the first 16 ends and picks of C, a wire shed occurs between the second and third of each group of three picks. A card is cut from each horizontal space of D for the weft sheds, all the weave marks being cut, while the cards for the wire sheds are obtained by cutting the full squares only on the first pick of each group of three. Then the complete order of lacing is two ground cards, one wire card, and one ground card in each group.

Fig. 433.

Combinations of Pile and Figured Warp Rib.—In the fabric shown in Fig. 433 the pile threads are interwoven in the ground; but in this case they are brought prominently to the surface of the cloth in the form of a warp rib, and they are also used for figuring in the ordinary manner. This method is largely employed, as by it the more costly threads are made use of to the greatest advantage. Two systems of combining the pile with a figured warp rib are illustrated in Fig. 434. In the first system the threads are arranged two ground to each pile and two picks to each wire, and the pile threads are raised alternately over the wires. The ground threads interweave with the weft in plain order throughout; hence they may be drawn on to two healds placed behind the harness in the manner illustrated at A in Fig. 426. A design is then drafted as shown at E in Fig. 434, in which each vertical space represents a pile thread, and each horizontal space two picks and a wire. The pile figure is indicated by a wash of colour, and plain weave is inserted over it, as shown by the full squares on the shaded figure in E; the crosses represent the warp figure, and the blanks the rib ground. From each horizontal space three cards are cut as follows:—First card, cut the crosses; the second card is all cut; third card, cut the full squares. The complete structure of 16 ends and 8 picks of the plan E is shown at F, in which it will be seen that on the even picks the odd ground ends are always raised along with the pile ends. These ends are given in more rapidly than the even ground ends, which are held very tight, so that they help the pile ends in forming the rib, the prominence of which is further accentuated by employing thick weft for the even picks and fine weft for the odd picks.

The second system of combining pile with figured warp rib is illustrated at G in Fig. 434, which shows the complete structure of the first eight picks of the plan E. The ends are arranged one ground, one pile, and where the pile is formed all the pile threads are raised over the wires; hence the pile figure is cut solid and not plain as indicated in E. There are three picks to each wire, and in the rib ground the ground threads are raised on the first pick and the pile threads on the second and third picks. In order to develop the rib structure the centre pick of each group of three is much thicker than the first and third.

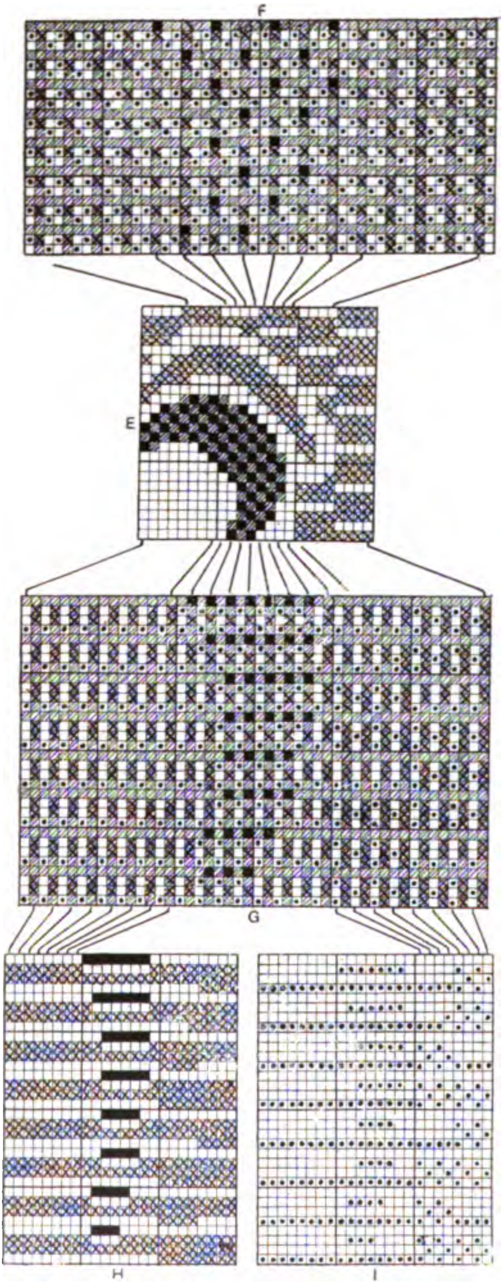


Fig. 434.

In this arrangement the ground threads work differently in different sections of the cloth; therefore they cannot be operated by healds, but must be drawn on the harness. If an ordinary harness draft is used the design will require to be indicated in full for the card-cutting, as shown at G. By employing a sectional harness tie and draft, however, such as is illustrated in Fig. 183 (p. 157), the cards may be cut from the solid plan. In the example the ground and pile threads are in equal proportions, therefore the hooks are divided into two equal parts A and B, and the harness cords are passed through separate longitudinal divisions A and B of the comber-board to correspond. The pile threads are drawn through the harness mails of the comber-board at the front, and the ground threads through those of the comber-board at the back, as represented in the lower portion of Fig. 183. The lifts of the pile threads are cut on the first half of each card, and of the ground threads on the second half, four cards being cut from each horizontal space of the plan E in Fig. 434, as follows :—

	Pile Section A.	Ground Section B.
First card, .	Cut the crosses.	Cut the pile figure, the blanks, and the crosses plain.
Second card,	All cut.	Cut the crosses reversed plain.
Third card,	Cut the crosses and the blanks.	Cut the pile figure and the crosses plain.
Fourth card,	Cut the pile figure.	All blank.

In order that a comparison may be made, the lifts that are cut on the pile and ground sections of the cards, from the first eight picks of E, are shown separately at H and I in Fig. 434; the combination of the harness tie and the draft produces an alternate arrangement of the threads, with the result that in the cloth the structure is as shown at G.

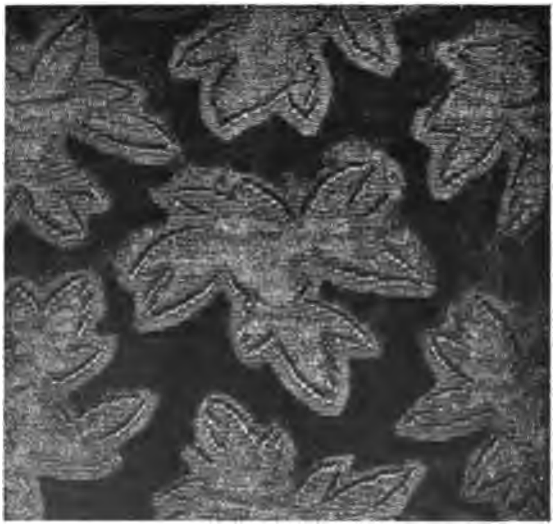


Fig. 435.

COMBINATIONS OF PILE AND DOUBLE-PLAIN CLOTH

The example illustrated in Fig. 435 shows a further development in which the pile is combined with warp rib, warp figure, and double-plain cloth, the respective sections being represented at J in Fig. 436 by the full squares, blanks, crosses, and shaded squares. The complete weaves of the several structures are shown at K; the arrangement in the warp is 2 silk, 1 cotton; and in the weft, 1 fine silk, 1 thick worsted, 1 fine silk, 1 wire. The silk ends work in pairs in the rib ground and warp figure; but in the pile section only one of each pair is raised over the wires, the other, along with the cotton end, forming the ground under the pile. In the double-plain section (in which the circles and diagonal strokes are shown in K) the silk ends form plain cloth on the surface with the silk picks, while the cotton ends similarly form plain cloth with the thick worsted picks on the back. In the rib ground the surface is spotted by the silk picks, which float over the silk ends and under the cotton ends. In an ordinary harness tie and draft this style requires to be designed in full, as shown at K, whereas with a sectional harness tie and draft the cards may be cut from a design marked solid, such as is indicated at J. In this case, as there are three series of ends, the hooks are divided into three sections, from each of which the harness cords are passed through a corresponding longitudinal section of the comber-board. The draft is then as shown at L in Fig. 436, in which A represents the pile warp section, B the silk warp section, and C the ground warp section. In cutting the cards from the solid plan J, four cards are cut from each horizontal space, as follows :—

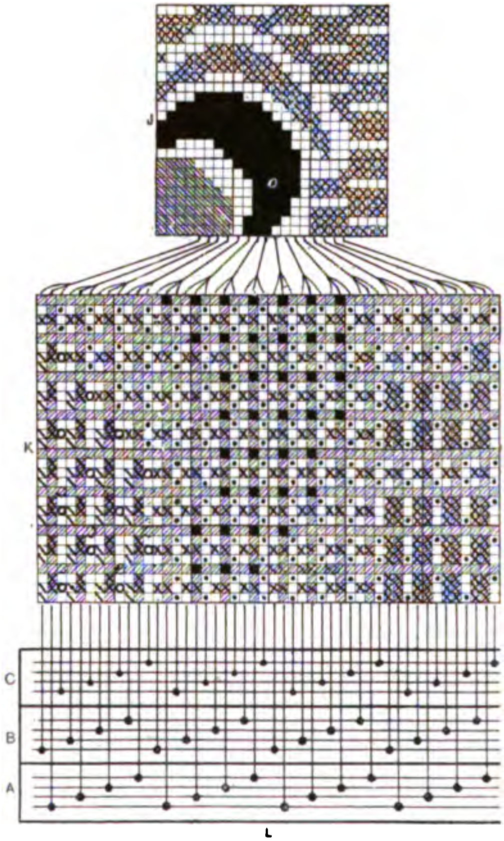


Fig. 436.

	Pile Section A.	Silk Section B.	Ground Section C.
First card, .	Cut the crosses.	Cut the crosses and the shaded squares.	Cut the blanks, the full squares, and the crosses plain.
Second card,	All cut.	All cut.	Cut the shaded squares plain
Third card,	Cut the crosses and the shaded squares.	Cut the crosses	Cut the blanks, the full squares, and the crosses reversed plain.
Fourth card,	Cut the full squares.	All blank.	All blank.

The cloth illustrated in Fig. 437 consists of a worsted pile figure on a double-plain silk crepon ground, but in this case the pile threads are only brought to the surface where the pile figure is formed. The structure is indicated in Fig. 438, where M shows a small plan in which the marks represent the pile figure and the blanks the double-plain ground; while the complete design to correspond is given at N. The warp is arranged 1 cotton, 1 worsted pile, 2 silk, and the weft, 2 silk, 1 wire, 1 worsted; in the worsted pile section the threads form a single cloth, while in the double-plain ground the silk ends and silk picks form the face, and the cotton and worsted ends and the worsted picks the back. The crepon effect is developed in the double plain by having the worsted weft hard twisted, which causes it to shrink when the cloth is submitted to moisture in the finishing operation. The first of each pair of silk ends works exactly the same in both the pile and the double plain, therefore these ends may be operated by a heald. By combining the heald draft with a sectional harness tie and draft, as represented at O, the

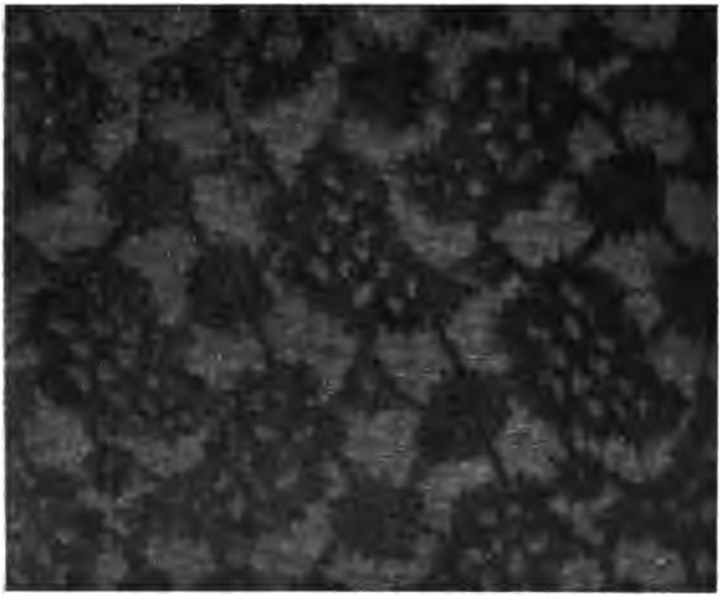


Fig. 437.

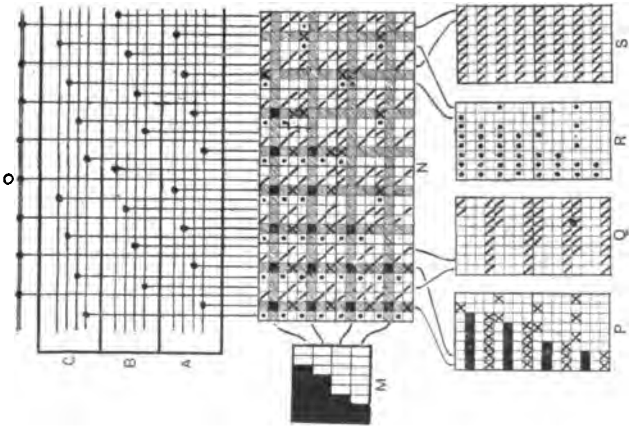


Fig. 438.

cards may be cut directly from a condensed plan such as is shown at M. The pile threads are drawn on Section A, the silk threads on the heald and section B, and the cotton threads on section C. Four cards are cut from each horizontal space of the solid plan, as follows:—

	Pile Section A.	Silk Section B.	Cotton Section C.	Heald.
First card, .	Cut the marks.	All cut.	All blank.	Depressed.
Second card,	All blank	All blank.	Cut the marks.	Raised.
Third card, .	Cut the marks.	All blank.	All blank.	Depressed.
Fourth card,	Cut the blanks plain.	Cut the blanks.	Cut the marks, and the blanks plain.	Raised.

The lifts that are cut from the plan M on the different sections of the cards are indicated separately at P, Q, and R, while S shows how the threads are raised by the heald; the threads are combined in the cloth in the order shown in the draft O, and the structure given at N results.

COMBINATION OF PILE AND WEFT FIGURE

The weft may be employed for figuring in conjunction with the pile, and in Fig. 439 a cloth is represented in which, between the pile sections, a figure is formed in two colours of weft. The pile threads are extra, and where not forming pile are floated on the back and are afterwards removed. The method of designing is illustrated at T in Fig. 440, the full squares indicating black pile figure, the circles gold weft figure, the diagonal strokes purple weft figure, and the blanks 2-and-2 warp rib ground. The complete structure of the centre 32 threads of the last eight picks of T is indicated at U; the arrangement in the warp is 1 cotton, 1 silk pile, 1 cotton, and in the weft, 1 gold silk, 1 wire, 1 purple silk. All the marks in U represent lifts except where the faint circles are inserted to show the figuring

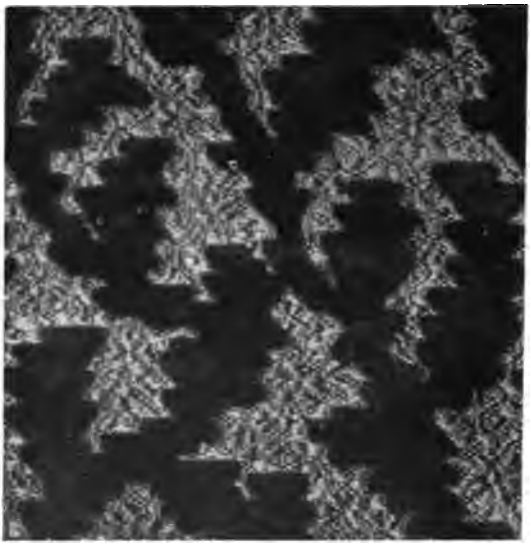


Fig. 439.

weft floats. All the warp threads require to be operated by the jacquard, and the most convenient arrangement, as regards the designing and card cutting, is a

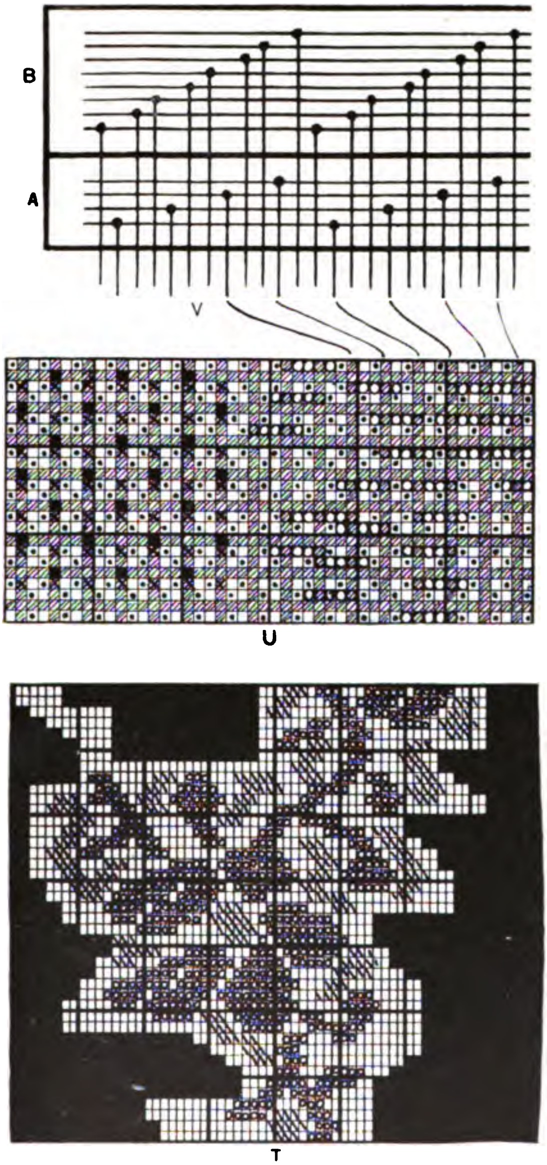


Fig. 440.

sectional harness tie and draft. In this case there is one pile thread to two ground threads, so that the former will occupy one-third of the hooks, and the latter two-thirds; while the corresponding longitudinal sections of the comber-board will be in similar proportions, as shown at A and B in the draft indicated at V. In the plan T each vertical space on the design paper represents a ground thread, whereas two spaces represent a pile thread, and for this reason at the edges of the pile figure the moves are marked in pairs of ends. In the cloth there are 64 ground and 32 pile threads per inch, and 90 picks and 45 wires per inch; the counts of the design paper is in the proportion of 64 ends to 45 picks of each colour per inch—viz., 8 × 6. Three cards are cut from each horizontal space of T, as follows:—

	Pile Section A.	Ground Section B.
First card (gold weft) . .	Cut the full squares.	Cut plain except the circles.
Second card (wire), . .	Cut the full squares plain.	All blank.
Third card (purple weft), .	All blank.	Cut plain except the diagonal strokes.

LOOPED PILE AND WARP-RIB FIGURE ON CUT PILE GROUND

Fig. 441 illustrates an upholstery cloth which consists of looped pile and warp figure on cut pile ground. In the pile structure (both cut and looped) the pile threads are not firmly bound in, but additional backing ends are interwoven on the underside to prevent the pile from being displaced. A in Fig. 442 shows a portion of the figure given in Fig. 441, and B the complete structure of a portion of the last eight picks of A, while C represents the heald-and-harness draft. In addition to a separate bobbin for each pile thread in a repeat of the design, one beam is required for the ground warp and another for the backing warp, the former contracting about 4 per cent. and the latter 42 per cent.; where the pile is

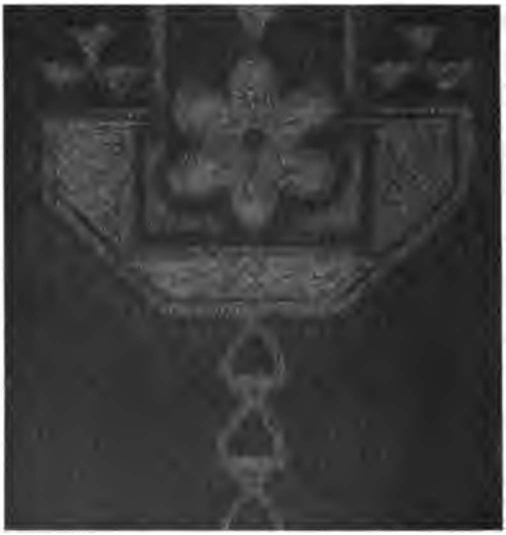


Fig. 441.

formed the ratio of pile warp to cloth is about 5 to 1. The pile warp is 2/36's worsted; the ground warp, two-ply 2/48's cotton; the backing warp, 2/30's cotton; and the weft, 2/36's cotton. The warp threads are arranged 1 ground, 1 backing, 1 pile, 1 backing, with 152 threads per inch; and the weft, 2 picks, 1 cutting wire, 1 looping wire, with 76 picks and 38 wires of each kind per inch. The counts of the design paper is in the proportion of the pile threads per inch (38) and the wires of each kind per inch—viz., 8 × 8. Where the pile is formed the threads are raised alternately over the wires, hence plain weave is inserted in both the cut and the looped pile sections of the design. In A, Fig. 442, the full squares indicate the lifts on the cutting wire sheds, and the dots on the looping wire sheds, while the crosses show where the pile threads form warp figure. Four cards are cut from each horizontal space of A as follows:—First card (ground pick), cut all the marks; the second card (ground pick) is all cut; third card (cutting wire), cut the full squares; fourth card (looping wire), cut the dots. The healds lift in the order indicated at D. In the complete structure of the cloth represented at B the full squares and the dots respectively show where the pile threads are raised over the cutting and looping wires, while the crosses indicate where the same threads are raised over the weft; the diagonal strokes show the lifts of the ground ends, and the circles of the backing ends. The warp figure is separated from the pile by a rib ground, the weave of which is shown at E; the lifts of the backing threads assist the pile threads in forming the rib.

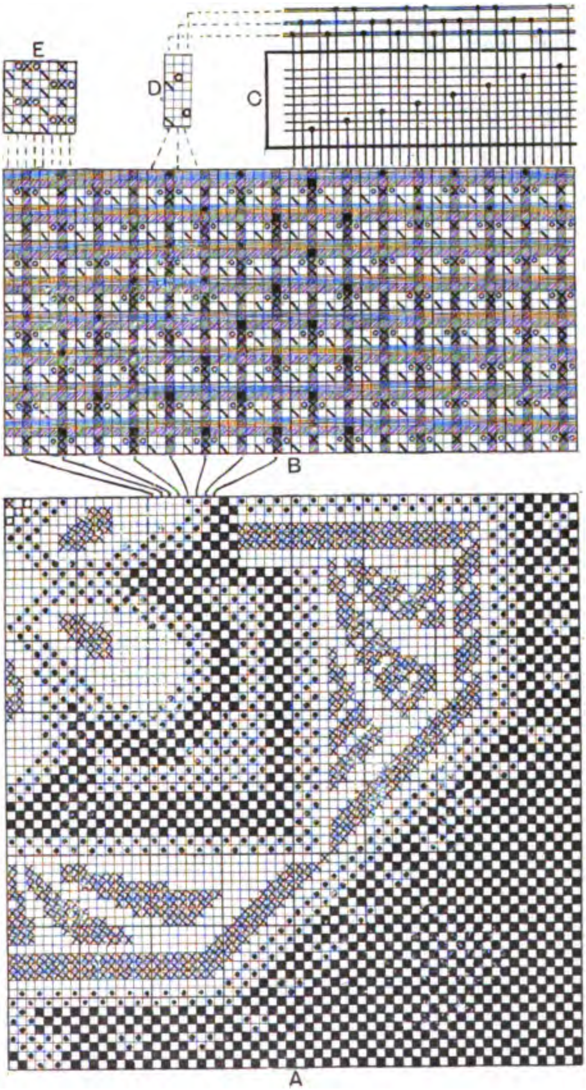


Fig. 442.

CHAPTER XX

FIGURED PILE FABRICS IN WHICH THE DESIGN IS DUE TO COLOUR

Wilton and Brussels Structures*—Comparison of the Cloths—Distinguishing Feature of the Cloths—Planting—Method of Designing—System of Loom Mounting—Card-cutting—Six-frame Mounting—Structure of Wilton Pile—Structure of Brussels Pile—Two-pick Wilton Pile Structure—Moresque Effects—Development of the Colours in both Cut and Looped Pile. *Tapestry Pile Carpets*—Comparison with Brussels and Wilton Structures—Tapestry Pile Designing—Preparation of the Pile Yarn for Printing—The Printing Drum—The Printing Pulley—The Scale Board—Operation of Printing—Beaming the Pile Warp—Structure of Tapestry Pile—Tapestry Pile Weaving. *Chenille or Patent Axminster Pile*—Comparison with Tapestry Pile—Chenille Pile Designing—Formation of the Chenille—Setting—Structure of the Fabric. *Moquette or Royal Axminster Pile.

SEVERAL important classes of pile textures, which include Wilton, Brussels, Tapestry, and Axminster carpets, and similar but lighter fabrics that are used for hanging and upholstery purposes, are woven with a uniform surface of either cut or looped pile. The chief purpose of the form or figure in these cloths is to serve as a medium for the display of colour. Special machines and processes are employed in their production, which enable the designs to be composed without regard to the method in which the threads interlace. It is only in the Wilton and Brussels structures that the use of a jacquard machine is required in forming the figure.

WILTON AND BRUSSELS PILE STRUCTURES

Comparison of the Cloths.—The principles of designing for Wilton and Brussels carpets, and corresponding hanging and upholstery cloths, are practically the same, while the cloths are very similar in structure. The chief differences between them are that in a typical Wilton carpet the pile is cut and there are three picks to each wire, whereas in a Brussels carpet the pile is looped and there are two picks to each wire. Wilton pile carpets require the insertion of three picks to each wire in order to ensure that the tufts will be held firm enough to resist the friction that is applied to the cloth, but cut pile hangings, in which the tufts are not so liable to be disturbed, are very largely made with two picks to each wire. A Wilton pile is generally composed of finer material, and is deeper than a Brussels pile ; and both structures, when used for hanging and upholstery purposes, are made lighter, finer, softer, and more flexible than when they are employed as carpets. Flax and jute yarns, made very stiff by sizing, are used for the foundation of carpets in order that the back will be firm and unyielding, whereas cotton yarns of a pliable nature enter into the foundation of hanging and upholstery cloths.

Distinguishing Feature of the Cloths.—In each longitudinal line of the Brussels and Wilton structures as many differently coloured pile threads are employed as there are different colours brought to the surface in the line. The pile threads are thus in sets or groups in which, so far as regards the pile structure, each thread is a duplicate of the others ; one thread in each group, of the proper colour according to the design, is raised over each wire. The cloths are classified according to the number of pile threads in each group, and technically the term " frame " is applied; thus, three-frame, four-frame, and five-frame are respectively applied to cloths in which there are three, four, and five duplicate, but differently coloured pile threads in each longitudinal line. The textures mostly range from two to five frames, but six frames are employed to some extent. In a five-frame cloth there are always four pile threads lying in the foundation to one thread on the surface, while in a four-frame three pile threads are in the foundation for each thread on the surface, and so on. Therefore the higher the number of the frame the greater is the consumption of the pile yarns, but (if other things are equal) this is accompanied by no improvement in the texture, except that the greater number of colours gives more scope to the designer, and the foundation is better as regards bulkiness and elasticity. The quantity of pile yarn used is not in direct proportion to the number of the frames, because, however many frames are employed, there is always one, but never more than one, thread of each group taken up rapidly by being raised over the wires. For example, assuming that the contraction of the pile threads in forming the pile is from 300 to 100, and in the foundation from 104 to 100: for 100 yards of cloth each group of threads in a six-frame effect will require $(1 \times 300) + (5 \times 104) = 820$ yards of pile yarn, whereas a three-frame pattern will require $(1 \times 300) + (2 \times 104) = 508$ yards of yarn, or about five-eighths the length that the pattern with twice as many colours requires.

Each pile thread is on a separate bobbin, and the bobbins are arranged in a creel behind the loom in layers to correspond with the frames. As many groups of threads are required in the width of a cloth as there are loops or tufts formed in each transverse line. In Brussels and Wilton carpets the number of groups in the standard width of 27 inches ranges from 260, or about 10 per inch, to as few as 130, or about 5 per inch, very thick pile yarns being employed for the latter; while the number of wires per inch ranges from 13 in the finest Wilton structures to about 7 in the cheapest qualities of Brussels. On the other hand, hanging and upholstery cloths are made finer, and from 18 to 14 groups of pile threads per inch, and from 18 to 14 wires per inch are employed.

Planting.—The number of colours in the width of a fabric is not limited to the number of frames employed; the threads in different groups may be differently coloured, in which case one, two, or more of the frames each contains more than one colour of pile. Thus, in a five-frame structure one portion of a design may require the colours 1, 2, 3, 4, and 5, and another portion the colours 1, 2, 3, 6, and 7, and yet another portion the colours 1, 2, 3, 8, and 7; the colours 1, 2, and 3 being constant, while the colours 4 and 5 are replaced by the colours 6 and 7, and then the colour 6 by the colour 8. The substitution of one colour for another is termed " planting," and if this is judiciously performed a design may be produced in a four or five-frame cloth which contains as many as—say—twenty colours. In the same quality the higher the number of the frame is the more costly is the cloth, on account of the greater quantity of pile yarn required, and frequently a cloth, by successful planting, is given the appearance of being produced in a higher frame, and, therefore, more costly than is actually the case. The chief point to note in planting is to avoid the formation of stripes in the woven design, and for this reason a planted colour is sometimes graduated at both sides towards the adjacent colours in the frame.

Method of Designing.—In originating a large design a neat sketch of the figure is usually first made in pencil to a reduced scale on plain paper, and the proper colours are then indicated more or less roughly on the several sections. In transferring the design to point-paper it is customary to use paper that is ruled according to the pitch of the cloth, so that in drawing and painting the figure it is shown exactly the size it will appear when woven. Also, it is usual to paint in the several parts of the ornament in the exact colours that it is intended to employ in the cloth, although subsequently the colours of the woven design may be changed by substituting other threads in the loom. Each vertical space of the design paper represents a group of pile threads, and each horizontal space a wire, hence each small square of the paper represents a loop or tuft. An illustration of a five-frame Wilton or cut-pile structure is given in Fig. 443, in which the same five colours are employed throughout. In Fig. 444, which corresponds with a portion of the design given in Fig. 443, the five colours are represented by different kinds of marks, as shown in the "gamut" below the plan; each mark in the plan indicates a pile tuft formed in the corresponding colour.

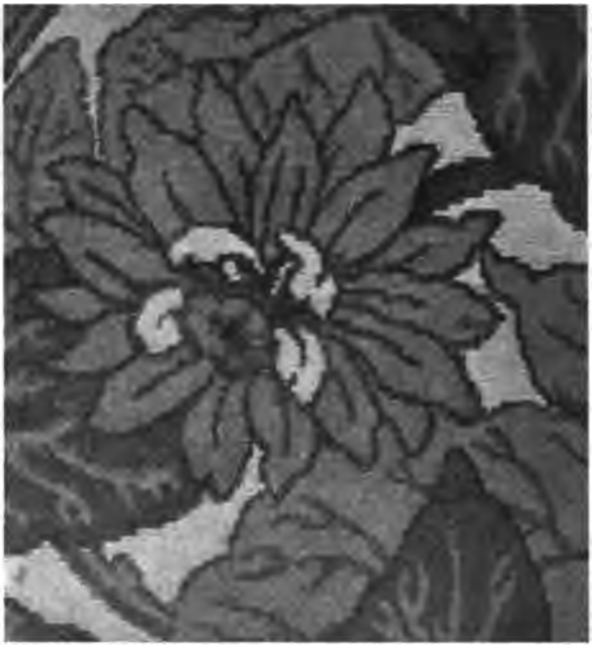


Fig. 443.

System of Loom Mounting.—A form of jacquard-harness and heald mounting is shown at A in Fig. 445, that is used in weaving the textures. The card cylinder is over the weaver's head, and in each short row there are 10 hooks and needles which are connected in the same manner as in an ordinary single-lift machine. The arrangement of ten per short row is convenient for five-frame designs, and any smaller frame can be woven by casting out in long rows. The harness is on the knotted comber-board principle, and the comber-board M is supported at each side by a strong flat bar N to which a vertical movement is given by means of a cam, all the harness being thus capable of being raised by the comber-board M at regular intervals. Behind the harness there are two ground (or fine chain) healds P and R, and a stuffer heald S, the latter being connected at each side to a bar N by means of a rod T, so that the stuffer ends are lifted at the same time as the harness ends are raised by the comber-board. The ground healds P and R are operated in reverse order by means of positive tappets.

In the diagram A in Fig. 445 the hooks, needles, and harness cords are shown bracketed together in pairs, and numbered to indicate the numbers of the frames —that is, the several colours of the pile warp that the respective parts control. At B in Fig. 445, which represents how the warp threads are drawn on the healds and harness, the pile threads are correspondingly numbered ; and the order of denting is indicated by the horizontal lines which connect the lower ends of the threads—two ground (or fine chain) threads, five pile threads, and one stuffer thread being passed through each split of the reed. In one split the five-pile threads are drawn on the odd rows of the harness, and in the next split on the even rows,

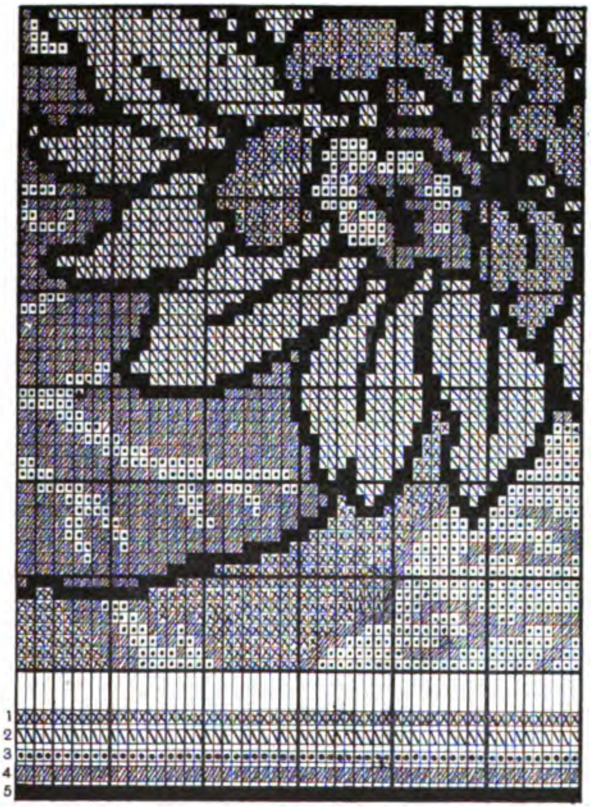


Fig. 444.

each colour being thus allocated to two consecutive rows of the harness, as shown by the numbers at the side of the harness draft. A comparison of the harness draft with the arrangement of the hooks and needles will show that the numbers coincide, and that each short row of the jacquard controls two pile threads of each colour.

Each vertical space of the design given in Fig. 444 represents one pile thread of each colour, so that two vertical spaces are equivalent to one row of needles and hooks, and one row of a card which is 10 holes deep. In carpets the design most frequently extends the full width of the texture, and if there are 260 groups of threads in the width a jacquard with a capacity of 1,300 needles is required. The machines are usually made with 1,320 needles divided into three sections of 440 needles each, while the card cylinder is similarly divided into three sections. and three separate sets of cards to correspond are employed. For upholstery cloths different sizes of machines are used according to the class of design required.

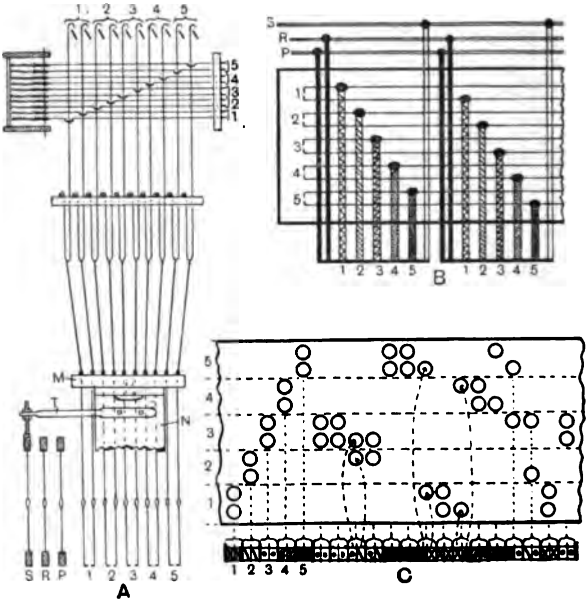


Fig. 445.

Card-cutting.—The system of card-cutting which corresponds with the draft B is illustrated at C in Fig. 445, where a portion of a card is represented as having been cut to coincide with one horizontal space of a five-frame design in which the same marks are used as in Fig. 444. A card may be considered to be in five longitudinal sections of two rows each, each section corresponding with a distinct colour of pile warp (a frame), as indicated by the numbers at the side of the example shown. The spaces in the card-cutting plan are bracketed together in pairs to coincide with the rows of the card, and two holes are cut in each row, the several colours or marks of the design being cut on the corresponding sections of the card. On the left of C the marks of the plan are arranged in the order of the frames, and numbered from one to five in order that they may be readily compared with the position of the corresponding holes in the card. Dotted lines also connect certain marks with the corresponding holes, and it will be seen that the first mark of a pair is cut on an odd row of the card, and the second mark on an even row. One card acts for as many picks as there are picks to a wire, and a wire is inserted at the same time as one of the picks.

Six-frame Mounting.—A six-frame design can be woven by employing 12 hooks and needles in each short row, and using a 12-rowed card, and this method is sometimes adopted. However, a mounting is illustrated in Fig. 446 by means of which a 10-rowed card can be used to produce a six-frame design. In this case there are 10 needles and 12 hooks in each row, of which 10 hooks, lettered A, are inverted, and when in the ordinary position are away from the path of the lifting knives, while the rear two hooks B face the cylinder, and are arranged over the lifting knives in the usual manner. Each needle is connected with both an inverted hook and a hook B, the five odd needles that govern one group of pile threads being connected to one hook B, and the five even needles that govern the next group to the other hook B. In order that an inverted hook A will be raised it is necessary for the corresponding needle to be pressed back by a blank in the card. If any one of either the odd or of the even needles is pressed back, the corresponding hook B is pushed off the lifting knife and is left down, the needles being provided with long eyes where they are connected with a hook B, in order that the latter may be acted upon without obstruction by any one of the five needles. If none of the odd, or of the even needles, is pressed back, the corresponding hook B remains vertical, and is raised by the griffe. In this system, therefore, in order that a pile thread governed by a hook A will be raised, four holes are cut in the card and one left blank. In order that a hook B will be raised, all the holes (five) are cut opposite the corresponding needles, a thread of the sixth frame being thus automatically lifted whenever none of the frames 1 to 5 is required up. In the card-cutting, therefore, all the card is cut except where the colours of the frames 1 to 5 are indicated. A five-frame design can be woven simply by casting out the rear two rows of the harness. Compared with the system illustrated at A in Fig. 445 the method has the disadvantage that as at least four-fifths of the holes are cut, the cards are weaker, are more readily damaged, and do not last so long.

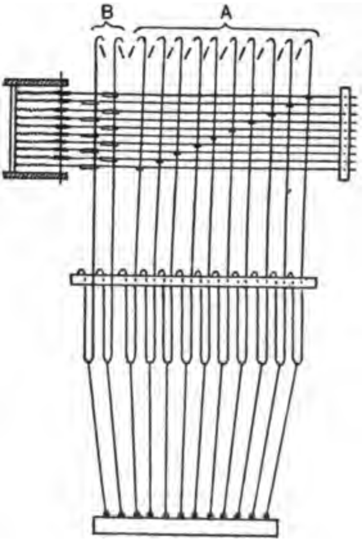


Fig. 446.

A modified form of the mounting, shown in Fig. 446, which, however, is the same in principle, is employed in which vertical cords (suspended from a stationary board at the top) are used instead of wire upright hooks, and a slotted lifting board instead of lifting knives, while a levelling board acts against the rear ends of the needles instead of springs.

Structure of Wilton Pile.—In Fig. 447 D shows a small plan in five colours, and E the complete structure of a Wilton pile to correspond; while F represents how the threads interlace in forming the pattern indicated in the first vertical space of D. The marks which represent the colours in the plan D are similar to those indicated in Fig. 444. A line is shown connecting each vertical space of D in Fig. 447 with five vertical spaces of E, at the top of which the colours are represented in the same order as in the gamut below the design in Fig. 444. To correspond with the three-pick Wilton structure each card acts while three picks and a wire are inserted.

The comber-board, and the stuffer heald along with it, are raised on the second of each group of three picks, and all the pile threads and the stuffer threads are lifted high enough to form a shed for the shuttle carrying the ground weft to pass through. On the same pick the jacquard griffe is raised a greater distance than the comber-board, and lifts up one pile thread in each group so that a second shed opening is made in which a wire is inserted below the threads which have to form pile. The full squares in E indicate the threads which are raised by the jacquard to form the upper wire shed; while the horizontal marks represent the pile threads, and the vertical strokes the stuffer threads which are raised by the comber-board and suffer heald respectively to form the lower weft shed. In conjunction with this order of lifting, the ground healds are operated alternately, and lift the ground threads in 3-and-3 order, as shown by the circles.

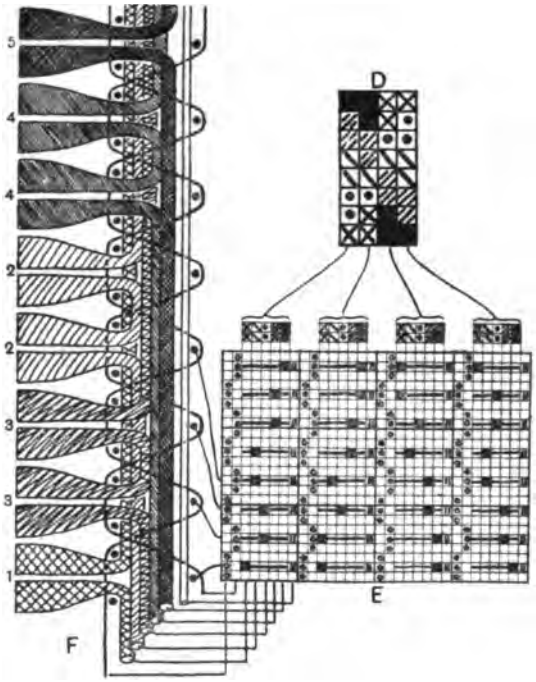


Fig. 447.

The fabric represented in Fig. 443 is an upholstery texture which is composed of two-ply 2/30's worsted warp, 2/12's cotton ground (or fine chain) warp, two-ply 2/16's cotton stuffer warp, and 2/14's cotton weft. The stuffer threads lie straight in the cloth, while the ground threads contract about 16 per cent.; the shrinkage in width is about 6 per cent. In the cloth there are 87½ pile threads, 35 ground threads, and 17½ stuffer threads per inch, and it is woven with 42 picks and 14 wires per inch, so that in the width there are 17½ and in the length 14 tufts per inch, giving a total of 245 tufts or points to the square inch. The counts of the design paper is in the ratio of 17½ tufts to 14 wires per inch, or 10 × 8; but the number of vertical and horizontal spaces in each large square is immaterial so long as they are in the right proportion for the design to be drawn to the proper scale. Since, however, two vertical spaces are equivalent to one row of the card, it is convenient, as regards the card-cutting, to have an even number of vertical spaces between the thick lines of the design paper.

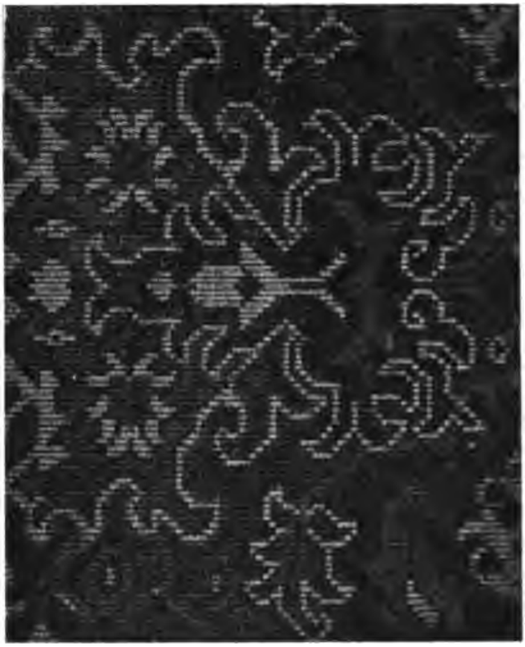


Fig. 448.

For a Wilton pile carpet suitable particulars are:—Three-ply 2/18's worsted pile warp, 3/8's cotton warp, 16 lbs. per spyndle jute stuffer warp, and 8 lbs. per spyndle flax weft, with 10 pile threads of each colour per inch, and 10 wires per inch. In making the design exactly the size that it will appear in the cloth to the foregoing particulars, each square inch of the design paper would be divided vertically and horizontally into ten spaces. In Fig. 444, however, the paper is 10 × 8, and the example would, therefore, be suitable for producing in a cloth with 10 pile threads of each colour and eight wires per inch.

Structure of Brussels Pile.—An illustration is given in Fig. 448 of a four-frame Brussels, or looped-pile structure, the design for a portion of which is shown in Fig. 449. The second, third, and fourth frames are each in the same colour throughout, but the first frame is planted in several colours, as shown in the gamut below the design. The system of designing is the same as in the previous example, each section of the design being painted out in the proper colour; and either of the foregoing systems of jacquard mounting may be employed with the harness cast out. The system of card-cutting is also the same, but all the colours of the planted frame are cut on the

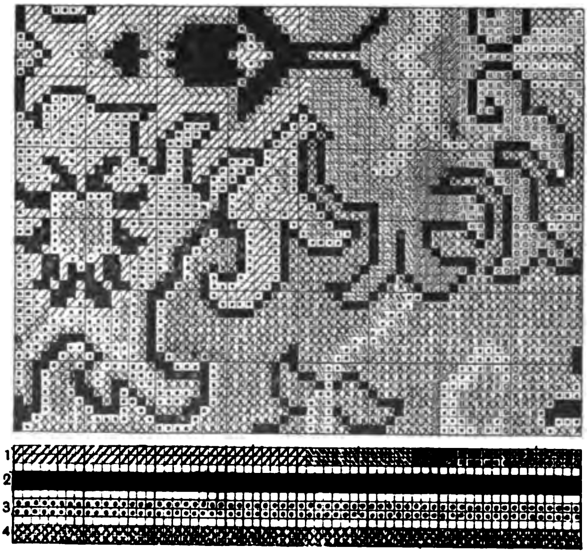


Fig 449.

same longitudinal section of the cards. A small plan in four colours is given at A in Fig. 450, while B shows the corresponding complete structure, and C the interlacing of the threads in forming the pattern in the first vertical space of A. The plan B is arranged similar to the plan E in Fig. 447, but in this case there are two picks to each wire, the comber-board, stüffer heald, and jacquard thus lifting on alternate picks (the even picks), while the ground healds work in 2-and-2 order. The particulars of the cloth shown in Fig. 448, which is an upholstery, are as follows:—Pile warp, two-ply 2/36's worsted; ground warp 2/16's cotton; stuffer warp, 2/12's cotton; weft, 2/12's cotton; 16 pile threads of each colour, and 16 wires per inch, giving 256 loops to the square inch. Cloths of this character are frequently made without stuffer warp.

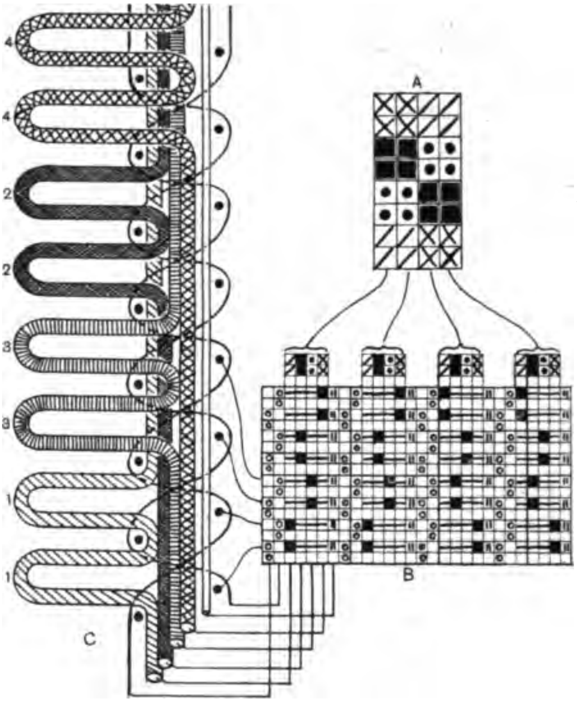


Fig. 450.

The following are suitable particulars for a Brussels carpet structure:—Pile warp, three-ply 2/16's worsted; ground or fine chain warp, 3/8's cotton; stuffer warp, 12 lbs. per spyndle jute; weft, 8 lbs. per spyndle flax; 9 threads of each colour of pile, and 9 wires per inch, giving 81 loops to the square inch. In this quality there are generally 234 groups of pile threads in the standard width of 27 inches.

Two-pick Wilton Pile Structure.—Fig. 451 illustrates a three-frame cut-pile upholstery cloth, the point-paper design for which is given in Fig. 452. The first frame is planted in two colours, while in the portions of the design indicated by brackets below the gamut, only the colours of the first and second frames are brought to the surface. As far as regards the design, the threads of the third frame can be omitted at these places, because if they are present they simply lie "dead" in the cloth. In order, however, that the foundation will be uniform in density, it is customary to introduce an equal number in each group, and sometimes old stock is used up as "dead" threads, while in other cases the pile threads are replaced by stuffer threads.

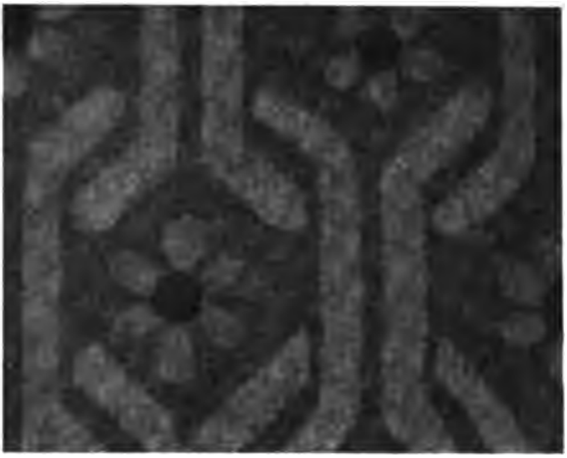


Fig. 451.

A small plan in three colours, similar to the design given in Fig. 452, is represented at D in Fig. 453, while E shows the corresponding complete structure of the cloth. Two picks are inserted to each wire, but there are no stuffer threads, while the ground threads work in plain order. The same mounting as before may be employed by casting out the harness, but the stuffer heald will be dispensed with, and the ground healds will be operated in plain order. In the illustration F shows the interlacing of the first pick of the plan E, and G of the second pick and the wire, which are inserted together. It will be found useful to compare the warp sections shown at F and G, with the weft sections given in Figs. 447 and 450, as the principle of construction is the same in each case. The cloth represented in Fig. 451 is composed of 3/22's worsted pile warp, 2/10's cotton ground warp, and 2/12's cotton weft, and there are 17 groups of threads and 16 wires per inch, giving 272 points to the square inch.

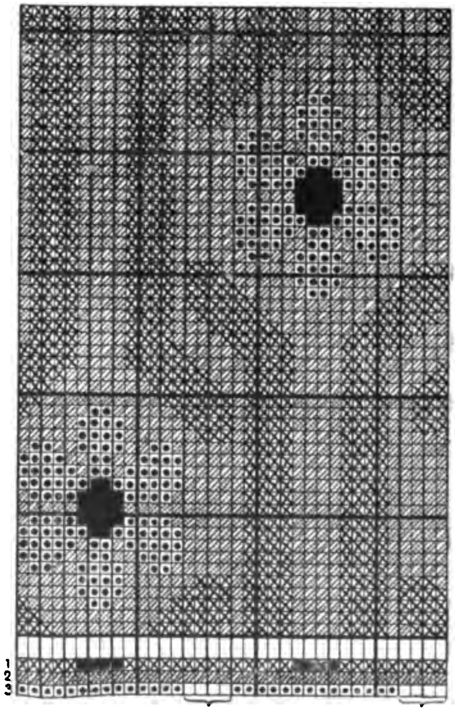


Fig. 452.

Moresque Effects.—Usually in the Wilton and Brussels structures each part of a design is developed in a solid colour, and it is to this that the characteristic clearness of design is chiefly due. In some cases, however, one or more sections of a design are developed in a mixture of two colours, to which the term "moresque" is applied. One method of producing a moresque effect is to use a pile thread which is composed of two or more separate but differently coloured threads that are twisted together. In another method each frame is in a distinct solid colour, but the threads of two frames are combined by lifting them together, such threads being half as thick as those that are used to form solid-coloured effects. For example, if five frames are used, and frames 1 and 2 are in 3-ply 2/18's yarn, and frames 3, 4, and 5 in 3/18's yarn—the solid colours of the frames 1 and 2 may be used in conjunction with mixed effects produced by combining the frames 3 and 4 together, 3 and 5 together, and 4 and 5 together. Five effects may thus be produced, and still further variety by planting, although, as regards the actual quantity of pile yarn used, the number of the frame is only 3½. A mixed effect produced in separate threads may be designed by indicating each colour on one-half of each small space of the paper; then in the card-cutting each space thus indicated represents two holes.

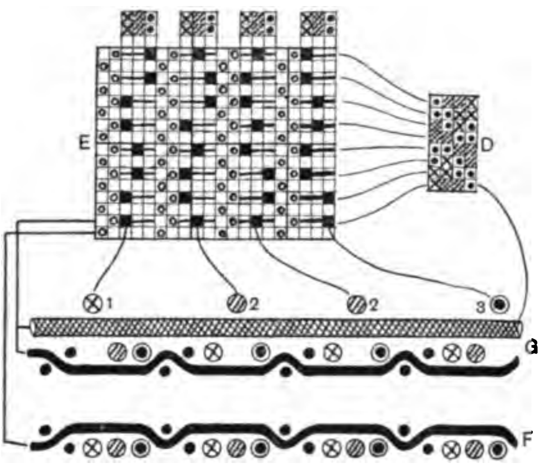


Fig. 453.

Fig. 454.

Development of the Colours in both Cut and Looped Pile.—Fig. 454 illustrates a three-frame upholstery cloth in which each colour is developed in both cut and looped pile, a design in six shades being thus produced from three colours of pile warp. A portion of the design is given at A in Fig. 455, in which the crosses, dots, and solid marks represent cut pile in the three colours, while the diagonal strokes, circles, and shaded squares indicate looped pile to correspond, as shown in the gamut below the design. The foundation of the cloth is the same as that of the cut-pile structure illustrated in Fig. 447, but for every three ground picks both a cutting and a looping wire shed are made, on one of which all the threads are left down except those that have to form the pile. Two cards are cut from each horizontal space of the design A, the crosses, dots, and full squares being cut on the first, and the diagonal strokes, circles, and shaded squares on the second. In order to illustrate the system of cutting more fully, a small plan is given at B in Fig. 455, with the corresponding complete order of cutting indicated at C. The cloth is constructed as follows :—Two-ply 2/36's worsted pile warp, 3/28's cotton ground warp, two-ply 2/20's cotton stuffer warp, 1/12's cotton weft; 18 pile threads of each colour per inch; 17 cutting wires and 17 looping wires per inch.

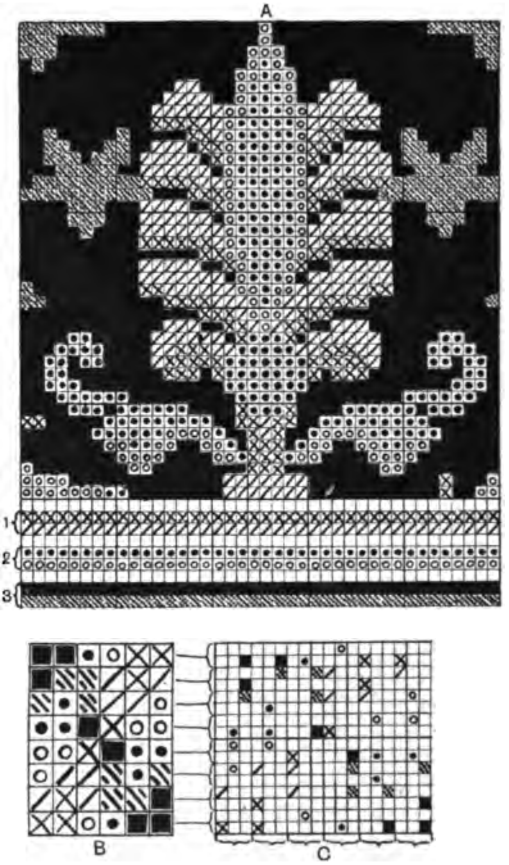


Fig. 455.

TAPESTRY PILE CARPETS

Comparison with Brussels and Wilton Structures.—The tapestry pile texture is made to resemble both the Brussels and Wilton structures. Compared with the latter structures, instead of from two to six duplicate solid-coloured pile threads (according to the number of frames) in each longitudinal line of the cloth, there is only one pile thread, which, however, is printed in different colours throughout its whole length in accordance with the colours that are required to show on the surface in the line. All the pile threads that are different from each other in a design are separately printed, and any number of colours may be applied to each thread. There is, therefore, no limitation to the number of colours that can be used (although for practical reasons it is not convenient to apply more than about forty in a design), whereas in the Brussels and Wilton structures there cannot be more than a certain number of colours woven in each longitudinal line. Further, in the tapestry pile structure the pile threads are all raised over the wires at the same time, and are, therefore, brought from one beam instead of each thread from a separate bobbin, while a tappet shedding motion is employed instead of a jacquard. The texture is, therefore, more economical to weave, and requires a smaller quantity of pile yarn than a Brussels or Wilton structure, but, on the other hand, the printing of the pile yarn is a more expensive process than solid-colour dyeing, while the cloth is inferior as regards bulkiness and springiness, and the design is not so definite and smart.

Tapestry Pile Designing.—The method which is chiefly employed in producing the tapestry pile texture is illustrated in Fig. 456. The principle of designing is the same as for the Brussels and Wilton structures; the design being painted out in the colours required in the cloth, on design paper of the proper pitch according to the number of pile threads and wires per inch. A in Fig. 456 represents a portion of a design in which the different marks indicate different colours. Each large square of the design paper corresponds to one square inch, and in the example is ruled to coincide with a cloth that is woven with eight pile threads and nine wires per inch. Each vertical space of the design represents a pile thread, and is termed a cord, while each horizontal space represents a wire, and is termed a type. Theoretically, each small space of the design represents a pile loop or tuft in the colour indicated, but this does not work out exactly in practice, partly because the colours "bleed," or run into each other, and because it is impossible to regulate the take-up of the pile threads to the wires with absolute accuracy, so that in the cloth the colour of a thread may change in any part of a loop or tuft.

Preparation of the Pile Yarn for Printing.—Previous to the printing operation the pile yarn is scoured and stoved in the hank form, then the threads are wound on to bobbins, from which they are wound side by side, as represented at C in Fig. 456, round the periphery of a large revolving drum with a wood surface which is covered with a sheet of oilcloth. The drums vary in circumference from about 6½ feet to 31½ feet and upwards, while the face is from 33 to 39 inches wide, and will accommodate about 960 threads wound alongside each other. The threads from several bobbins are passed through guide eyes spaced at suitable distances apart, and are wound on the drum at the same time. As the winding proceeds the guide eyes are moved slowly in a horizontal direction, and as many circuits of the thread from each bobbin are made as will uniformly fill the space between the separate threads. The face of the drum may be completely or partly filled by the threads; in the latter case fewer bobbins than the full capacity of the drum are wound from so that the surface is left uncovered at one side. In completely filling a drum, six bobbins, for example, may be used with the threads spaced 6 inches apart, and 160 circuits of the thread from each bobbin be made in filling the spaces between the separate threads. If the drum is 18¾ feet in circumference—(160 circuits × 18¾) ÷ 3 = 1,000 yards of yarn are drawn from each bobbin, or a total of 6,000 yards from the six bobbins. If only four bobbins are wound from, two-thirds of the surface of the drum will be filled, and with the same length of yarn drawn from each bobbin, a total length of 4,000 yards of yarn will be obtained. The length of yarn drawn from each bobbin is treated separately after the printing operation, and is called a hank, and each hank supplies one thread of the pile warp that is subsequently placed on the weaver's beam. The length of thread that can be used to form a hank is limited for various practical reasons, one of which is that it should not exceed what can be placed upon a "setter's" bobbin.

The Printing Drum.—A printing drum is provided at one side near the rim with a series of ratchet teeth, represented at R in Fig. 456, which are engaged by a pawl or catch P. The pitch of the teeth is arranged to coincide with the length of yarn that it is estimated will form one loop. Thus, assuming that 3 inches of pile yarn are required to form 1 inch of cloth with 9 wires per inch, in changing the catch P from one tooth to the next, the yarn on the surface of the drum will be moved 3 inches ÷ 9 wires per inch = ⅓ inch. The circumference of a drum is divided into a definite number of teeth, usually a number which is a multiple of several smaller numbers, and the teeth are numbered on an index alongside from 1 upward. A drum with 648 teeth will permit the printing of a design repeating in length on 648 loops, or wires, or horizontal spaces of the design paper, or on any number which is a division of 648. Each tooth represents a traverse of the printing pulley, or a type, or a horizontal space of the design.

A drum generally has two indices each provided with ratchet teeth, one index being coarser than the other in order that the drum may be used for textures which are different in pitch and in length of pile. Thus, one index of a drum may have 648 teeth to the circumference, and the other 432; then if the former gives $\frac{1}{3}$ inch of pile yarn to each loop or type, the latter will give $\frac{1}{2}$ inch. Suitable sizes of drums, with the number of teeth to the circumference, are as follows:—18 feet 9 inches circumference with 648 teeth in the fine pitch and 432 teeth in the coarse pitch; 25 feet 6 inches with 864 and 576 teeth; 28 feet 10 inches with 972 and 648 teeth; and 31 feet 6 inches with 1,062 and 708 teeth. The largest sizes are used more especially in the manufacture of carpet squares. In every case the fine pitch gives 0·35 inch to each type, and the coarse pitch, 0·534 inch, or rather more than $\frac{1}{3}$ inch and $\frac{1}{2}$ inch respectively. A small drum is also used which is 6 feet 5 inches in circumference, with 216 teeth, the pitch being the same as the fine pitch of the large drums.

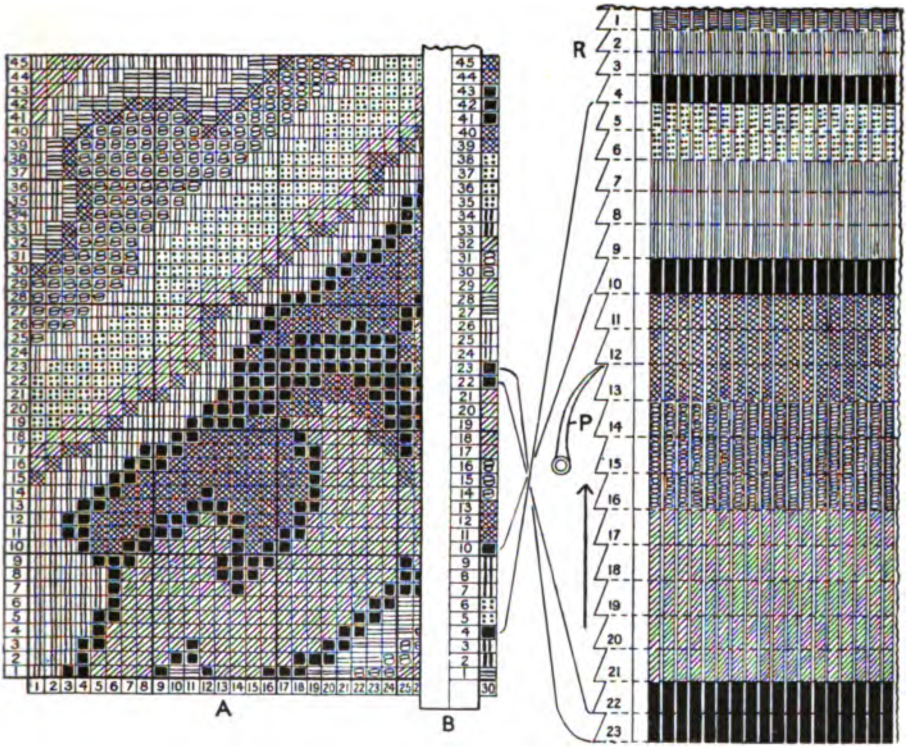


Fig. 456.

The Printing Pulley.—Situated immediately underneath the drum is a metal carriage which is provided with four grooved wheels that rest on a pair of rails running the width of the drum. The carriage is so constructed that a colour box can be readily put in or taken out; and as many colour boxes are employed as there are different colours in the design to be printed. Each colour box contains a supply of the proper dye solution, and the colour is applied to the pile yarn, while it is wound round the drum, by means of a printing pulley which is partly immersed in the liquid. The width of the face of the printing pulley is approximately equal to the distance that the yarn is moved by the drum when the latter is turned one tooth. The carriage is made to traverse the breadth of the drum, and the printing pulley revolves in the dye solution and runs with its upper surface in contact with the yarn, thus printing on the threads the colour which is contained in the colour box. The width of colour printed at each traverse is equal, theoretically, to the length of yarn required to form one loop or tuft, and corresponds to one wire or one horizontal space of the design paper. If only part of the width of the drum is covered with yarn the printing pulley is automatically "dipped" or lowered out of contact with the surface which is uncovered.

The Scale Board.—A large design is divided longitudinally into sections each of such a width that it can be conveniently handled during printing, and each portion is pasted to a separate board and then varnished. If the time available for printing a design is limited two or more of the separate sections may be printed simultaneously at different drums. As shown in A Fig. 456, the spaces of the design are numbered along the bottom to indicate the number of each pile thread in the design, and at the side, to correspond with the numbering of the teeth of the drum. The printer uses as a guide a narrow piece of wood with a bevelled edge, termed a scale board, which is divided by horizontal lies to suit the pitch of the design paper, as shown at B in Fig. 456; and the horizontal spaces of the scale board are also numbered to correspond with the numbering of the teeth of the drum. The scale board is placed on the design with the bevelled edge alongside the vertical cord (or thread) to be printed—No. 30 in Fig. 456—with the numbers on the board and at the side of the design coinciding.

Operation of Printing.—Each colour of the design is indicated by a letter or number, and the colour box which contains the corresponding colour is similarly indicated in order to avoid trouble in selecting the colours. The colour, which is judged to be the most suitable to print first, is selected, and assuming that this is represented by the solid marks, which, in the cord numbered 30 in Fig. 456, are indicated on the spaces numbered 4, 10, 22, 23, etc., the drum is turned by means of a hand wheel so that the pawl P engages in succession the teeth that are correspondingly numbered. At each engagement the printing carriage, containing the proper colour box, is traversed with the scroll pulley in contact with the threads. When all the types of the cord 30, which correspond with the spaces on which the first colour is indicated, have been printed round the entire circuit of the drum, the colour box is changed for one containing another colour. Assuming that this is represented by the vertical marks in the cord No. 30 in Fig. 456, the drum is then turned so that the pawl P engages the teeth numbered 2, 3, 7, 8, 9, etc., in succession. The printing of each colour is completed round the circumference of the drum before another colour is commenced, and the process is continued until the last colour has been applied and every portion of the threads has been printed the proper hue. C in Fig. 456 represents a portion of a drum covered with threads which are printed to coincide with the types 1 to 23 of the vertical cord numbered 30; and a few connecting lines are shown between the horizontal spaces of the cord and the teeth that are correspondingly numbered. The drum is rotated in the direction shown by the arrow.

If a design repeats in length on ½, ⅓, or ¼, of the number of teeth of the drum, each colour is carried forward round the drum for a corresponding number of repeats before the colour box is changed. Thus, assuming that the design shown at A in Fig. 456 repeats on 216 horizontal spaces or types, and that the drum has 648 teeth, the design will be repeated three times in the circumference, and the first colour (indicated by the solid marks) will be printed with the pawl engaging the teeth 4, 10, 22, 23, etc., then the teeth 220, 226, 238, 239, etc., and then the teeth 436, 442, 454, 455, etc., and so on. In such a case a scale board would be used which is divided vertically into three portions, the first numbered from 1 to 216, the second from 217 to 432, and the third from 433 to 648.

If all the threads in a design are different from each other each vertical cord represents one filling of the drum and one operation of printing; thus, if there are 216 different threads in the repeat the printing process is repeated 216 times. The printer works at two drums alternately—printing at one while the yarn is prepared at the other. In the case of "centred," or "wheel," designs, in which one-half of the design is like the other half, but turned over or round, each filling of the drum and process of printing enables two threads to be obtained, so that 216 threads of such a design can be produced by repeating the process 108 times. In small repeating designs the number of printing processes may be reduced to one-third, one-fourth, etc., the number of pile threads in the width of the cloth. Carpet "squares" are made up to 144 inches wide, but they are generally designed on the centred or wheel principle; and from 288 to 576 separate processes of printing are necessary (according to the pitch of the cloth and the form of the design) in producing a "square" 72 inches to the half width.

The operation of printing a design is, therefore, a long and tedious process (occupying from two or three weeks for an ordinary design to eight or ten weeks for a large square if only one printer is employed), but a very large number of repeats of the design can be produced at one printing operation. For instance, if a drum has 648 teeth, and there are 648 wires in the repeat of the design, as many repeats are printed at the same time as there are threads alongside each other on the drum; while three times as many repeats as threads are printed, if the design occupies one-third of the number of teeth, or 216 wires. Thus, if 160 circuits are made from each of six bobbins, 960 repeats are obtained if there is only one repeat to the complete circle of the drum, and 2,880 repeats if there are three repeats to the circumference. With nine wires per inch the approximate length of carpet produced by one complete operation of printing will be :—(648 types × 960 threads) ÷ 9 wires = 69,120 inches or 1,920 yards.

Processes that Follow Printing.—Following the complete printing of each drumful, the next process is "rubbing," in which a piece of wood with a flat end is rubbed over the surface of the yarn on the drum, each colour being treated in succession. This process causes the colouring matter to more completely penetrate the threads, and at the same time superfluous colour is removed. The drum is then stripped by lifting the sheet of oilcloth clear away along with the threads, and to the latter a ticket is attached that is numbered to coincide with the number of the vertical cord in the design, and each hank (or thread from a separate bobbin) is tied separately.

The processes of steaming (to fix the colours), washing, and drying follow, then the thread from each hank is wound on to a setter's bobbin, which is numbered to correspond with the number of the thread. After all the threads of a design have been wound, the bobbins, by means of the numbers upon them, are placed in proper order in a bank or creel in readiness for the beaming. Assuming that six hanks (previously wound from six bobbins) have been printed at each filling of the drum, the creel will be filled six times if all the threads in the design are different from each other, and three times if the design is centred or on the wheel principle. Each filling of the creel with setter's bobbins usually supplies the yarn for one pile warp.

Beaming the Pile Warp.—The winding of the pile threads on to the weaver's beam requires to be very carefully performed, and is done in a special manner as in this process the printed threads have to be so placed alongside each other that the colours are brought in correct relative position *horizontally* according to the design. In front of the bobbin creel there is a carriage with two rack wheels at each side, the teeth of which fit into the teeth of two rack rails fixed to the floor. The pile threads are passed from the bobbins through a reed at the rear of the carriage, then between a pair of flat bars which can be clasped together, and over a setting board (at the front of the carriage) that has grooved horizontal lines on its surface There is also a pair of clasp bars in front of the warp beam stand at the other end of the rack rails. The warp is run on to the beam in short lengths at a time, the threads being first compared with and set to the design with the aid of the grooved lines on the setting board, then held firmly by the clamps connected to the carriage while the threads are wound on to the beam, during which the carriage is moved forward on the rack rails. The clamps in front of the warp beam stand are then closed and those in front of the carriage opened while the latter is run back on the rails, when the pile threads are again adjusted to the design on the setting board. The process is repeated, the carriage being run to and fro between the creel and the warp beam, throughout the length of the warp. The design shows in an elongated form on the threads as they are wound on to the beam.

Structure of Tapestry Pile.—The structure of a looped pile tapestry carpet is illustrated in Fig. 457, in which E shows a small design, and F the corresponding complete plan of the cloth. Each group of threads consists of two ground or fine chain threads, one pile thread, and three stuffer threads, which are passed through one split of the reed. G shows how the threads in the first group interlace with the picks, the pile thread changing colour, as represented by the different markings. to correspond with the different marks shown in the first vertical space of E. The similarity of the structure to that of the Brussels pile will be seen by comparing G with C in Fig. 450. A large quantity of stuffer yarn is introduced in the tapestry cloths in place of the pile threads, which, in the Brussels structure, lie in the foundation.

Tapestry Pile Weaving.—There are two picks to each wire, and the same as in Brussels pile weaving, a double shed is formed and a wire is inserted at the same time as each alternate pick of weft. The pile and the stuffer threads, which are lifted on the even picks in the plan F, Fig. 457, are drawn on the same heald. This heald, however, is provided with a special form of mail, as shown at H in Fig. 457, and the pile threads are passed through small eyes K, and the stuffer threads through long eyes L. The heald is placed at the front, and is given a greater movement than the two healds which carry the fine chain threads, with the result that an upper line of pile threads is formed below which a wire is inserted. At the same time the lower portion of the long eyes of the mails raises the stuffer threads level with the fine chain threads that are lifted by one of the fine chain healds to form the top line of the weft shed.

Cut-pile tapestry cloths are largely made with two picks to each wire, a cutting wire being used in place of a looping wire, but in some cases, in order to render the cut pile firmer, three picks are inserted to each wire. The structure is then the same as the Wilton pile structure illustrated at F in Fig. 447, except that there is only one pile thread in each group, and a greater number of stuffer threads are introduced.

The particulars of a good quality of a worsted tapestry pile carpet are as follows :—Three-ply 2/15's worsted pile, 3/8's cotton fine chain, 14 lbs. per spyndle jute stuffer, 8 lbs. per spyndle hemp weft; 8 pile threads and 9 wires per inch; 88 inches of carpet from 225 inches of pile yarn. In lower qualities the number of pile threads and wires is reduced to about 6½ per inch, jute is used instead of cotton for the fine chain warp, and from 112 to 125 inches of carpet are produced from 252 inches of pile yarn.

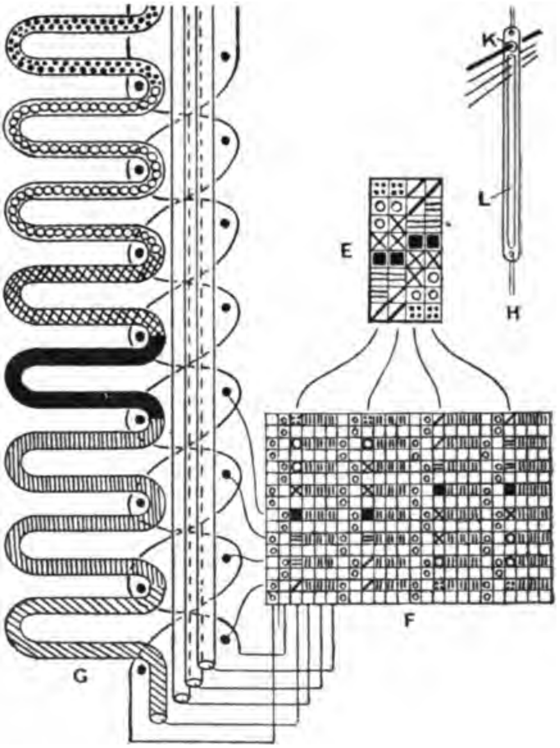


Fig. 457.

A heavy woollen rug may be made with 160 pile threads, on 30 inches, of 4/125 yards per ounce woollen; 18½ wires on 3 inches, 2-ply 14 lb. jute stuffer, 3-ply 7 lb. jute fine chain, and 2-ply 8 lb. jute weft.

The bleeding or running of the colours into each other is one of the chief sources of irregularity in designs for these textures, light colours suffering most. The difficulty is got over to some extent by allowing a relatively larger number of cords in the design for the lighter colours; while, again, a narrower printing pulley may be employed for the dark than for the light colours.

CHENILLE, OR PATENT AXMINSTER PILE

The distinctive features of chenille Axminster pile fabrics are:—(1) A cut pile is produced without the aid of wires, (2) all the pile material is on the surface of a foundation cloth, (3) any number of colours can be employed, each of which appears definite and smart. Two separate operations of weaving are required in producing the texture. In the first operation, which is termed "weft weaving," the pile yarn, in the form of weft, is interwoven with groups of warp threads that are placed some distance apart. This is followed by a process in which the fabric is converted into a number of long threads that form the chenille pile, which in the second operation of weaving (termed setting) is inserted as weft in such a manner as to form the pile surface of a foundation texture.

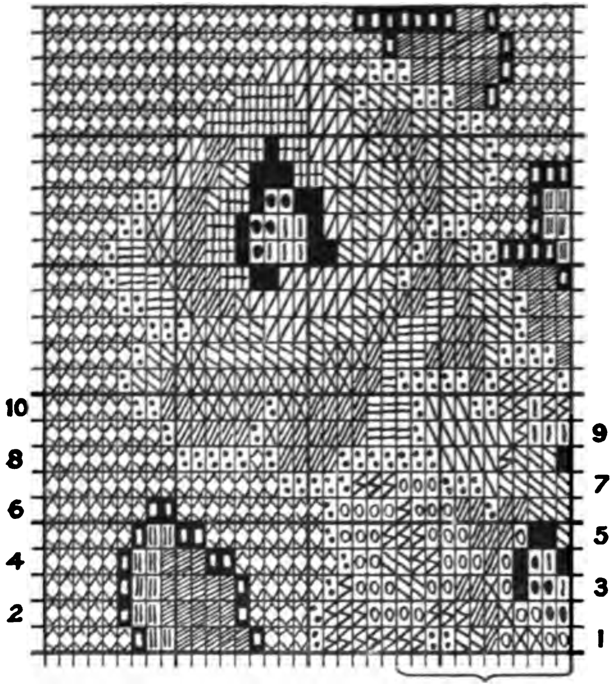


Fig. 458.

Comparison with Tapestry Pile.—The mode of preparing the chenille produces a certain degree of similarity in the pile to the printed tapestry pile, as in both cases any number of colours can be introduced, the colours are arranged in the pile threads in the exact order in which they are required to show in the cloth, while a large number of repeats of the design are obtained at one operation. In a chenille thread, however, the colours are developed in the form of tufts of fibres (a looped pile cannot be woven on the chenille principle), and each colour is quite distinct from the neighbouring colours. In a tapestry pile thread, on the other hand, the colours run into each other, and are not clearly defined at their joinings, while the pile (which may be either looped or cut) is produced during the subsequent weaving of the texture. Further, the chenille thread is traversed from side to side of the cloth, whereas the tapestry pile thread is introduced longitudinally.

Chenille Pile Designing.—The principle of designing is the same as in other pile textures in which the pattern is due to diversity of colour, the design being painted out exactly as it is required to appear when woven. On account of the means employed in producing the cloth it is of greater importance in this than in any other class of pile that the design be drafted on paper to the proper size, and for this reason a special quality of design paper is generally used.

A portion of a chenille Axminster design is illustrated in Fig. 458, in which 16 different colours are represented by as many different marks. Each large square of the design paper, which represents 1 square inch, is divided into 9 spaces vertically and 5 spaces horizontally, each vertical space corresponding to two picks of the weft which forms the chenille, and each horizontal space to one chenille thread. The design paper is thus ruled in the proportion of one-half the number of picks put in during the first weaving operation to the number of chenille threads inserted in the second weaving operation. Each small space of the design paper represents two pile tufts formed in the colour that the mark indicates.

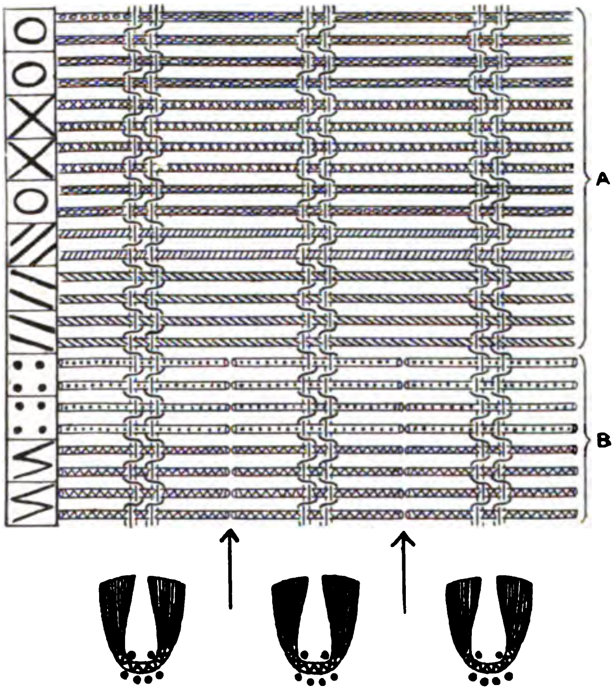


Fig. 459.

The pitch of design paper shown in Fig. 458 is suitable for a texture in which the chenille threads are woven with 18 picks per inch, and which contains 5 chenille threads per inch, giving 90 tufts to the square inch. The pitch varies greatly in different cloths, ranging from 26 picks per inch in the chenille and 12 chenille threads per inch (giving 312 tufts to the square inch) to 8 picks per inch in the chenille and 3 chenille threads per inch (giving 24 tufts to the square inch). For the former each square inch of the design paper is divided into 13 × 12 spaces, and for the latter into 4 × 3 spaces.

Although a design may repeat two or more times across the width, it must be extended to the full width of the texture to be woven. The horizontal spaces are numbered in consecutive order, the odd numbers on the right and the even numbers on the left, as shown in Fig. 458.

Formation of the Chenille.—In weaving the chenille the design is turned so that the horizontal spaces are in line with the warp threads, and the cords or spaces are gone through in succession, beginning at the bottom and then at the top of succeeding cords, where the number is indicated. The weaver uses as many shuttles (which are changed by hand) as there are colours in the design, and two picks of the proper colour of weft are inserted to each horizontal space in a cord. This is illustrated in Fig. 459, which shows the order of wefting to correspond with the bracketed portion of the first horizontal space of Fig. 458, an enlarged plan of which is given on the left of Fig. 459. The different colours are inserted in the order indicated in the design until the given longitudinal cord is completed, then a small space may be left without weft in order that in the setting the chenille thread will more readily turn at the sides of the cloth. Afterwards, the next longitudinal cord is gone through in the same manner, but in the opposite direction, and the process is continued until every cord in the repeat has been gone over.

The total length of chenille thread required to produce a design is equal to the length of a cord (originally a horizontal space) multiplied by the number of cords. Assuming that in the repeat of a design there are 120 chenille threads which are different from each other, and that 216 double weft picks are inserted in weaving each chenille thread the width of the cloth, there will be 120 × 216 × 2 = 51.840 picks inserted in producing the chenille for the full design. However, a large number of chenille threads may be woven alongside each other at the same time, so that one operation of chenille weaving enables very many repeats of the design to be obtained. Moreover, in the case of wheel designs and designs which are centred horizontally, it is only necessary to weave one-half of the chenille threads in the repeat in order to produce the full pattern.

For convenience in selecting the shuttles in the weft weaving each colour in the design may be indicated by a number, and the shuttles containing the corresponding colours be numbered to coincide. Two methods are employed by which the weaver is enabled to compare the distances woven in the different colours with the spaces occupied by the respective colours in the design. In a recent system the design is suspended vertically, and is made to travel up and down at the rate that the fabric is drawn forward in the loom, while from the position of a pointer, which can be slid laterally from one vertical space to the next as each is completed, it can be seen when the proper number of picks of each colour have been inserted. In an older system, which is still largely used, the design is cut into strips, each two cords wide, and each strip is in turn attached to the cloth, passed through a wide space in the reed, and lightly weighted at the other end. The strip is drawn forward with the fabric, and as each colour in a cord reaches the edge the shuttle, with the corresponding colour, is inserted. After the first cord is completed the strip is turned round and the second space is similarly gone through.

The chenille is woven in a plain loom which is fitted with a gauze mounting. The warp threads are arranged one end crossing two standard ends, and two groups of threads are reeded into consecutive splits of the reed with a space between them and the next two groups. Frequently, an ordinary form of reed is used, a number of splits being left empty between the groups of warp threads, but in some cases the reed contains splits only where the groups of threads are required to pass through. The space between the groups is varied according to the length of pile required, the pitch ranging from about $\frac{3}{8}$ inch for a short pile to 1 inch and over for a very deep pile.

Fig. 459 shows how the threads interlace, as viewed from the side that is underneath during the weaving of the chenille. A texture is produced across which the variously coloured picks of weft extend, being firmly bound in at intervals by the gauze interlacing, as shown in the portion lettered A in Fig. 459. The next process consists of cutting the picks in the centre of the space between the groups of gauze threads, as represented at B. This is followed by a process in which the strips are subjected to heat, moisture, and pressure, which causes each to assume the form of a thread in which the severed weft picks are shaped as illustrated below B. The threads are then indicated by a letter or number, and each is wound separately in a convenient form for subsequent use.

All the chenille threads that are woven alongside each other (with the exception of the selvage threads which are wasted) are, of course, exactly alike, and as many threads—within the capacity of the loom—are woven at the same time as will give the required number of repeats of the design. The counts of the pile weft is usually equal to 2's or 3's worsted, and may be 2/4's, three-ply 2/12's, or two-ply 2/12's worsted, but for a very deep coarse pile a yarn ranging from 30 to 40 yards per ounce may be used. The gauze threads are generally equal to about 10's or 12's cotton, and 3/30's or 4/50's may be used for the crossing threads, and 2/24's or 3/36's for the standard threads. For 100 yards of chenille thread about 115 yards of the standard threads, and from 170 to 220 yards of the crossing threads are required, the lengths varying according to the thickness of the weft and the number of picks per inch.

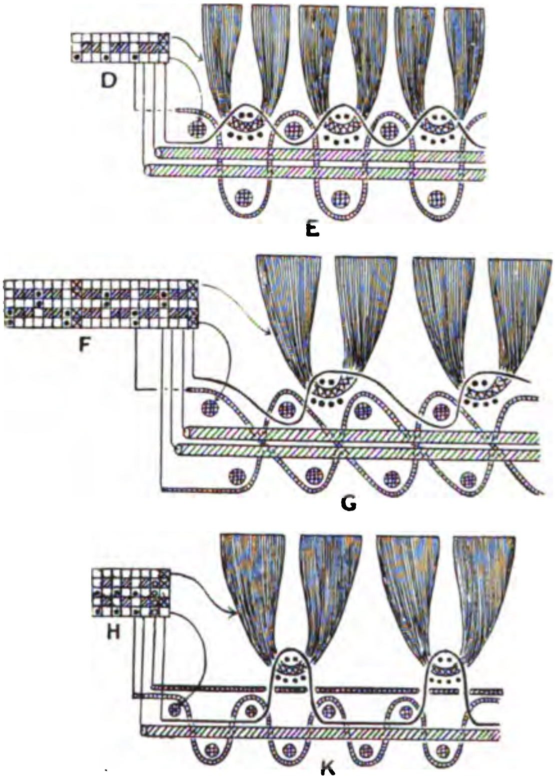


Fig. 460.

Setting. — In this — the second weaving operation— the chenille pile thread, in which the differently coloured tufts are arranged in precise order according to the design, is traversed from side to side, and is bound in by means of a fine linen or cotton warp to the surface of a foundation texture. The length of each pile thread that is taken up at each horizontal traverse is equal to the width of a horizontal space of the design. In a recent method of "setting," a length of the chenille thread is placed within an oblong metal case in such a manner that when it is withdrawn it is free from twists. The case is placed in a specially shaped shuttle, and the chenille is woven into the cloth in the same way as weft, except that the loom stops after the insertion of each pick of chenille while the weaver combs the thread forward and "sets" it in the proper relative position to the preceding pick of chenille.

Structure of the Fabric.—The structure of the foundation varies according to the purpose of the fabric—table covers, hangings, etc., being made lighter and more flexible in the foundation than carpets and rugs which require to be very stiff. D in Fig. 460 shows the weave plan, and E a cross-section through the weft of a structure in which there are two picks to each chenille thread, one ground end to two stuffer ends, and one fine binder end or catcher to every nine ends of the foundation. F and G similarly show a weave plan and a cross-section of a structure in which there are four picks to each chenille thread, one ground end to two stuffer ends, and two fine catcher ends to eighteen ends of the foundation. Both structures may be woven with nine ground ends, eighteen stuffer ends, and three catcher ends per inch, while for the first example, 12 picks and 6 chenille threads per inch are suitable, and for the second, 16 picks and 4 chenille threads per inch. The catcher ends unite the chenille pile threads to the foundation, as shown in the diagrams E and G.

H and K in Fig. 460 illustrate another structure which is woven with 4 picks to each chenille thread. In this case the warp is arranged 1 ground end, 1 stuffer end for three times, 1 float end, and 1 fine catcher end. The float end is raised over all the picks of the foundation, but passes under the chenille thread, and the object of its insertion is to raise the chenille above the foundation and bring it more prominently to the face. In each example given in Fig. 460 only the fine catcher ends pass over the chenille pile threads.

MOQUETTE, OR ROYAL AXMINSTER PILE

Royal Axminster pile belongs to the tufted class, the designs for which are painted out in exactly the same manner as for chenille Axminsters, and like the latter they possess practically no restrictions as to the number of colours that can be introduced. The sectional plan given in Fig. 458 will, therefore, serve to illustrate the method of designing for the cloths. The tufted pile may be formed by hand, as in certain classes of Eastern carpets and rugs, or by machinery, the latter method being now much more commonly employed because of its greater productiveness and cheapness.

In machine tufting the differently dyed pile yarns are first wound side by side on bobbins which are as long as the width of the texture to be woven, and a separate bobbin is employed for each horizontal space in the design—that is, each horizontal row of tufts. As many tufting bobbins are, therefore, employed as there are horizontal spaces in the repeat of the design, and the bobbins, which are numbered from one upwards to coincide with the horizontal spaces, are arranged in consecutive order in two endless chains by which they are carried. As many pile threads are wound on to each bobbin as there are tufts of pile to be formed in the width of the cloth, and these threads are arranged as to colour in the order in which the colours are indicated in the corresponding horizontal space of the design. Assuming that a design repeats upon 144 vertical spaces, and 216 horizontal spaces, 144 tufts will be formed in each horizontal line of pile, and 216 bobbins will be used, each containing 144 threads. A separate thread is provided for every small space in the design, and each thread is dyed the colour that is indicated upon the corresponding space.

The chains carrying the bobbins are slowly rotated, and a fresh bobbin is presented every 4 or 6, etc., picks. The pile threads from each bobbin are passed separately through tubes, and each time a row of tufts is formed a length sufficient to form a tuft is cut off each thread. This is inserted in the shed, and passed below a double weft pick with the free ends pointing upward. (The method of inserting the weft causes the picks to run in pairs.) One type of this class of structure is illustrated in Fig. 461. In the weave given at A, the picks, which are double in the cloth, are shown separately, the dots indicating the lifts of the ground or fine chain threads, the shaded squares the lifts of the stuffer threads, while the oval marks indicate the picks under which the pile tufts are inserted. The diagram B represents how the threads interlace with the picks; the latter are shown arranged to correspond with the order in which they are inserted, whereas in the cloth the two picks in the lower line are directly below those in the upper line, and thus form a back to the pile tufts. In the example three double picks are inserted to each row of tufts.

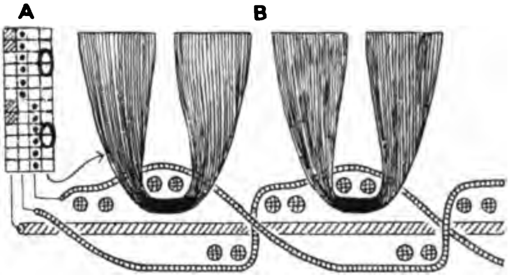


Fig. 461.

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